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From Inefficient to Efficient Renewable Heating: A Critical Assessment of the EU Renewable Energy Directive

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Abstract: The accounting methodology for renewable energy in the European Union's (EU) renewable heating and cooling targets is often treated as a mere technical detail, yet it has profound implications for the effectiveness of climate policies. This paper highlights a critical misalignment within the Renewable Energy Directive (RED), which inadvertently disincentivises the deployment of more efficient heating technologies. By accounting for the energy harnessed to produce the useful heat, rather than the useful heat itself, the current metrics disproportionately credit the least efficient heating systems with generating the most renewable heat. An electric heat pump with a seasonal performance factor of 3 producing 100 units of renewable heat gets credited with 100 units of heat, despite using only 33 units of input energy, whereas a wood fireplace with an efficiency of 50% gets credited with 200 units of heat. The less efficient the device, the more renewable credits it receives for producing the same amount of useful heat. This misalignment undermines decarbonisation efforts by over-crediting inefficient technologies while failing to fully recognise high-efficiency solutions like heat pumps. This paper proposes revising the RED to account for useful energy output, ensuring a more accurate reflection of technology contributions. We also propose increasing the binding heating and cooling targets of 0.8 pp/year and 1.1 pp/year so that they reflect the needed contribution of the heating and cooling sector to reach the binding headline target of 42.5% by 2030. This shift would incentivise efficiency, better align with EU climate goals, and support the transition to a low-carbon heating and cooling sector in line with the 2030 emissions reduction target.

Keywords: renewable energy; heating; heat pumps; climate protection

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1. Introduction

Renewable energy stands at the forefront of the European Union's strategy to reduce dependence on Russian fossil fuels and achieve its ambitious target of cutting greenhouse gas emissions by at least 55% by 2030 [1]. Central to this approach is the Renewable Energy Directive (RED), which establishes an overarching renewable energy target and sector-specific subtargets designed to accelerate the adoption of renewables across EU Member States [2,3].

The RED is a cornerstone of the European Union's climate and energy policy framework. It is worth studying not only because it sets legally binding targets for renewable energy deployment across member states, but also because it exemplifies how supranational governance can drive structural transformation in national energy systems. As the EU accounts for one of the world's largest energy markets and has committed to achieving climate neutrality by 2050, the RED plays a critical role in aligning energy policy with broader environmental, economic, and geopolitical objectives. Moreover, successive revisions of the Directive (RED I, II, and III) reflect evolving ambitions, policy mechanisms, and implementation challenges—making it a rich subject for analysing policy design, effectiveness, compliance dynamics, and regulatory innovation in the context of the global energy transition.

Heating in buildings represents nearly one-third of the EU's total energy demand, with an alarming 75% of this heat still generated from fossil fuels [4]. To meet the EU's enhanced climate targets for 2030 and beyond, decarbonising heating must become a core priority. Achieving this will necessitate a dual strategy: a robust programme of energy efficiency measures, coupled with a substantial transition to renewable heat sources [5].

The European Commission's 2040 climate target envisions a transformative shift in heating fuels. In 2021, fossil fuels—coal, oil, and gas—accounted for nearly half of the residential sector's final energy consumption. By 2030, this share is expected to be reduced to just 30%, with coal reduced by 41%, oil consumption reduced by 20%, and fossil gas by as much as 68% [6]. For buildings, there is an indicative target in the 2023 revision of the RED (RED III) of at least a 49% renewable energy share by 2030, which can be expected to primarily be driven by the deployment of heat pumps. Heat pumps harness ambient heat from air, ground, or water using electricity, thus providing a highly efficient pathway to decarbonise heating.

When the RED was introduced in 2009 it did not include any explicit, mandatory targets for renewable heating and cooling [7]. However, it required Member States to promote the use of renewable energy in the heating and cooling sector as part of their National Renewable Energy Action Plans (NREAPs). The overall binding target was to achieve 20% renewable energy in gross final energy consumption by 2020, which included contributions from heating and cooling, electricity, and transport sectors. When the directive was revised in 2018 (RED II) it for the first time included indicative and specific targets for heat. The target was defined as an annual increase of 1.3 percentage points in the share of renewable energy in the heating and cooling sector for each Member State from 2021 to 2030 [8]. RED III, part of the Fit for 55 package, was revised in 2021 [9] and entered into force in 2023. For the first time, RED III introduces binding targets for renewable heating. Member States must increase the share of renewable energy in heating by an average of 0.8 percentage points per year from 2021 to 2025 and by 1.1 percentage points per year from 2026 to 2030, based on the 2020 levels.

However, despite the fact that the RED now includes binding targets for renewable heat, we argue in this paper that the current legal framework under RED is misaligned with the ambition required to meet European climate objectives. Our analysis reveals that while RED sets commendable targets for renewable heating and cooling (although it could be argued that they are still too low to meet the climate targets), it inadvertently promotes inefficient applications of renewable energy within buildings. The Directive's metric for assessing renewable heating and cooling contributions tends to favour lower-efficiency technologies.

To address these shortcomings, we propose targeted reforms to the RED framework. First, we outline the existing EU approach to renewable heating and cooling. Next, we analyse how the current legal framework addresses technological efficiencies and the unintended consequences this has produced. We then introduce an alternative efficiency-based metric that would foster a more balanced and effective deployment of renewable heating technologies. Finally, we discuss the broader implications of our findings and offer specific, actionable policy recommendations aimed at aligning RED more closely with the EU's climate goals. In conclusion, aligning the RED with a more efficiency-focused approach is essential. Doing so will not only accelerate the decarbonisation of heating but also ensure that renewable energy deployment in the EU is both effective and sustainable.

2. Decarbonising Heating and Cooling in the European Union

The EU's RED goes back to 2009 and has provided the framework in which EU member states develop their renewable energy policies, including renewable heating and cooling [7–10]. Historically, renewable heating has not received sufficient policy support at the European level [11,12], and existing provisions for renewable heating and cooling are relatively weak and only recently have become mandatory.

2.1. Previous Provisions in the RED

The RED remains a crucial instrument through which the European Union legislates the expansion of renewable energy in heating and cooling. Under the recast RED II, adopted in 2018, Article 23 outlined an indicative target aimed at fostering this transition. Specifically, it recommended a voluntary annual increase of 1.1 percentage points in the share of renewable energy used for heating and cooling across Member States. For those Member States leveraging waste heat—a critical component in enhancing overall energy efficiency—the suggested annual increase rose to 1.3 percentage points. This approach reflects the EU's recognition of the pivotal role renewable heating and cooling play in meeting broader decarbonisation goals, while also highlighting the need for flexible yet ambitious frameworks that accommodate varying national circumstances [13].

2.2. Reform of the RED

The European Union's renewable energy ambitions for 2030 have been recently revised. In July 2021, as part of the Fit for 55 package, the European Commission unveiled its proposal for the revised RED (RED III) [14]. This proposal introduced a notable shift: making the previously voluntary 1.1 percentage point annual increase in renewable heating and cooling mandatory for all Member States.

However, the geopolitical landscape changed dramatically with the Russian invasion of Ukraine in February 2022. This crisis intensified the EU's determination to reduce dependency on Russian fossil fuel imports, particularly natural gas. Analyses conducted in response to the invasion highlighted the critical role of energy efficiency measures and the electrification of heating in rapidly cutting gas imports [15–17].

To address these challenges, the European Commission launched the REPowerEU plan in May 2022, a bold initiative aimed at phasing out Russian fossil fuels and expediting the clean energy transition. REPowerEU proposed increasing the 2030 renewable energy target to 45%—a significant jump from the 32% target under RED II and the 40% proposed in Fit for 55. Additionally, it called for doubling the annual deployment rate of heat pumps [18]. Yet, despite these ambitious goals, corresponding policy measures have yet to materialise.

By July 2022, the European Parliament's Committee on Industry, Research and Energy (ITRE) took further action, endorsing a more ambitious trajectory. The committee originally proposed elevating the renewable heating and cooling target to an indicative 2.5 percentage points per year, and 2.8 percentage points for Member States utilising waste heat and cold [19].

However, the final negotiated RED III contains much lower targets close to the original Commission proposal: Member States must increase the share of renewable energy in heating by an average of 0.8 percentage points per year between 2021 and 2025, and by 1.1 percentage points per year from 2026 to 2030, using 2020 levels as the starting point.

2.3. Targets Compared to Current Trends

According to the latest available data, the EU achieved a renewable energy share of 26.2% in heating and cooling in 2023, up from 11.4% in 2004 [20]. This translates to an average annual increase of just 0.8 percentage points—only 70% of the pace required by the original RED II targets.

If this growth trajectory continues, the EU is projected to reach a 32.5% share of renewables in heating and cooling by 2030. This estimate is based on the compound annual growth rate observed from 2010 to 2020. However, this forecast falls short of key benchmarks. Whilst it meets the 32% share implied by the Fit for 55 target, it is significantly lower than the 43% level required as implied by the headline target (Figure 1). Considering that heating and cooling still accounts for around half of the EU's final energy consumption, if the binding headline target is to be met, the renewable share of heating and cooling will have to reach at least 43% unless the share of renewable energy reaches significantly higher levels in the electricity and transport sectors.

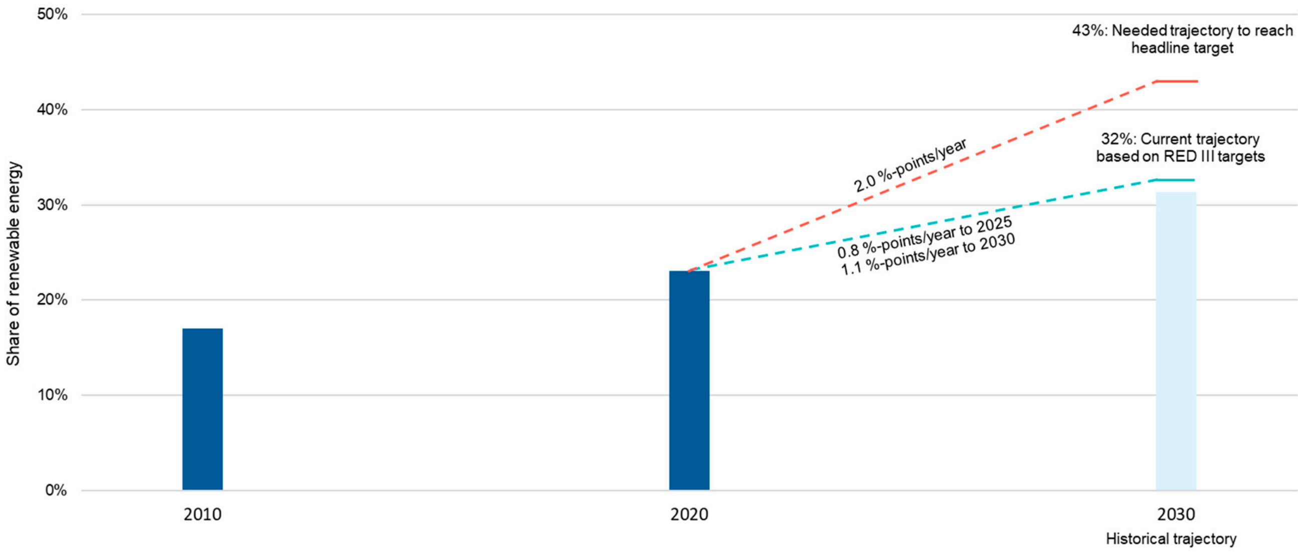

Figure 1. Share of renewables in energy for heating and cooling with indicative targets for 2010 and 2020 and projection for 2030. The dotted lines represent the trajectory from 2020 based on the EU's Renewable Energy Directive mandates of annual percentage point increases (blue) and necessary trajectory to meet the headline target (red).

These levels are reached by simply taking the headline economy-wide target of 42.5% and assuming that heating and cooling maintains a 50% share of final energy demand. Considering that the share of renewables in electricity was around 45% in 2023, it is possible that higher shares in electricity could partially compensate for lower shares in heating and cooling. However, even if electricity was 80% renewable in 2030, heating and cooling would still need to be at least 40% renewable to reach the headline target (assuming that the renewable share in transport increases only marginally). These hypothetical calculations are shown in Table 1 and underline that substantial progress is needed in the heating and cooling sector to reach the headline targets.

The current trajectory also falls well short of the 48% level proposed by the European Parliament in August 2022. These implied targets represent the levels necessary by 2030 if the annual increases of 1.1 percentage points (RED III) and 2.0 percentage points (implied required pace) are achieved.

This analysis underscores the urgency for the EU to adopt more robust measures to accelerate the deployment of renewable heating and cooling technologies. Achieving these higher targets will require not only stronger policy frameworks but also a renewed focus on scalable, high-efficiency solutions such as heat pumps and district heating systems. Without decisive action, the EU risks falling short of its climate commitments and missing the opportunity to enhance its energy security through greater reliance on domestically produced renewable energy.

Table 1. Contribution to the EU's headline target by sector, 2020 contribution, and hypothetical 2030 contribution.

	Final Energy Share	Actual RE Share 2020	Contribution, 2020	Hypothetical RE Share 2030	Contribution, 2030
Electricity	25%	37.4%	9.4%	80%	20.0%
Heating and Cooling	49%	23.0%	11.3%	40.1%	19.6%
Transport	26%	10.3%	2.7%	11%	2.9%

3. Current Metrics for Heating in the RED

The methodology used to account for renewable heating and cooling technologies in meeting high-level renewable energy targets plays a pivotal role in determining which technologies contribute and to what extent. This section outlines the existing framework and examines how it influences the contribution of various technologies towards the renewable heating and cooling targets.

While often regarded as technical nuances, these measurement metrics have far-reaching consequences. They shape the strategic choices made by Member States when designing policies to comply with renewable energy obligations. The way renewable energy contributions are calculated can either incentivise the deployment of efficient, scalable solutions or inadvertently promote less effective technologies. Understanding these implications is essential for aligning national strategies with the overarching decarbonisation goals of the European Union.

3.1. Existing Calculation Methodology

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 the following:

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 (EnergyRES). To calculate the renewable heating and cooling share, this figure is then divided by the total energy used for heating and cooling.

$$\text{Share}_{\text{RES}} = \text{Energy}_{\text{RES}} / \text{Energy}_{\text{tot}}$$

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

In accordance with Article 7 of RED II, EnergyRES is defined as the "gross final consumption of energy from renewable sources in the heating and cooling sector". This definition is further specified 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' [21].

In accordance with the European Union's regulation on energy statistics (Regulation (EC) No 1099/2008), space and water heating are categorised as energy services that involve the "use of energy to generate heat for indoor spaces or to heat water" [22]. In other terms, the definition of 'final energy' in the context of renewable heating and cooling refers to the fuels utilised in the production of heat, rather than the heat itself as a useful output.

This results in a disincentive for the adoption of more efficient technologies, as heat production technologies exhibit significantly varying conversion efficiencies [23]. An electric heat pump operating at a coefficient of performance (COP) of 3, for example, typically produces 100 kilowatt hours (kWh) of heat with 33 kWh of input energy (electricity) and operates at high efficiency even in sub-zero temperatures [24]. A 100% efficient electrical resistance heater requires 100 kWh of input energy to achieve a given amount of useful heat. In contrast, an 85% efficient pellet boiler necessitates 117 kWh, while a 50% efficient wood fireplace requires 200 kWh to produce the same heat output. Thus, less efficient technologies demand a greater quantity of final energy to deliver an equivalent amount of useful heat.

The issue was previously compounded by the fact that the RED did not account for electricity used for heating or cooling when calculating the gross final consumption of energy from renewable sources in the heating and cooling sector. Although electricity can be regarded as a fuel in heat production, it had been excluded from the heating and cooling statistics. Consequently, electricity utilised to operate heat pumps was not incorporated into the renewable heating and cooling target. In the case of heat pumps, only the ambient heat was considered (Table 2), which is dependent on the seasonal performance factor of the heat pump, as discussed in the subsequent section.

Table 2. Energy required to produce 100 units of useful heat and corresponding renewable value under the RED [1].

Technology	Technology Efficiency (Share of usable energy compared to energy input)	Energy Input (Calorific value of combusted fuels)	EnergyRES (Gross final consumption of energy from renewable sources)
Wood fireplace	50%	200	200
Pellet boiler	85%	117	117
Electric resistance heater	100%	100	0
Electric heat pump	300%	33	100

[1] Energy Input refers to the calorific value of combusted fuels and excludes ambient heat.

This was changed in RED III, which now counts the renewable electricity used for heating and cooling if devices have an efficiency above 100%. This wording avoids crediting electric resistance heaters with a renewable contribution, but allows electricity used to power heat pumps to be counted. It also counts waste heat.

3.2. Treatment of Heat Pumps

Heat pumps represent a unique case in energy statistics due to their use of a refrigeration cycle to transfer thermal energy from a low-temperature source to a higher temperature sink. This process effectively harnesses a virtually inexhaustible source of ambient energy, such as external air. Heat pumps rely on an external energy source (input energy) to drive this transfer of thermal energy.

The RED III accounts for both the input energy, typically electricity, as renewable heat as well as the ambient energy utilised by heat pumps through a simplified calculation based on an average seasonal performance factor (SPF).

$$\text{Energy}_{\text{RES}} = \text{Q}_{\text{usable}} \times (1 - 1/\text{SPF}) + Elec_{heat_{RES}}$$

The seasonal performance factor (SPF) represents the estimated average efficiency of a heat pump over a heating season, while Q_{usable} denotes the total useful heat delivered by the heat pump. $Elec_{heat_{RES}}$ refers to the renewable component of the electricity supply used to power the heat pump, calculated based on the country's average share of renewable electricity supply over the previous two years. According to this definition and considering the typical SPF of a heat pump, ambient energy contributes the highest amount when calculating the renewable energy output of heat pumps. If, for example, the electricity has a 33% renewable share and the SPF is 3, the total useful heat will be 78% renewable, composed of 67 units ambient heat + 11 units renewable electricity. (Figure 2) This is an improvement from the previous RED, which did not consider renewable electricity at all, and highlights still that the higher the efficiency of the technology, the greater the proportion of its heat that is classified as renewable.

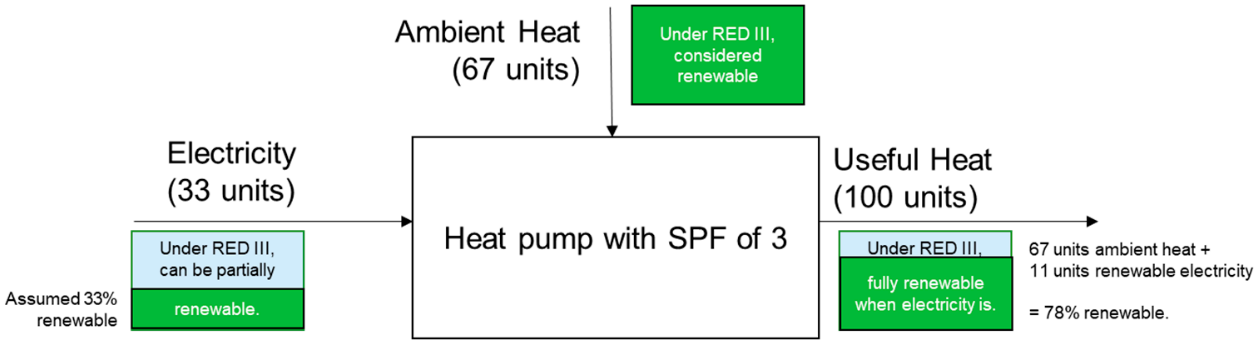

Figure 2. Definition of renewable heat from a heat pump in the RED. The units represent hypothetical quantities of heat to illustrate the definition of renewable heating in the Renewable Energy Directive.

As the decarbonisation of the European electricity grid progresses, the amount of renewable heating provided by heat pumps will naturally increase. Now that the renewable share of electricity is incorporated into the RED's methodology as part of the heating and cooling services provided by heat pumps, the incentive to promote their use is significantly stronger. This adjustment encourages Member States to adopt policies aimed at achieving the heating and cooling targets, while simultaneously fostering the wider deployment of efficient heat pumps to achieve these objectives.

3.3. Overall Impacts of the Efficiency Metrics

Renewable heating and cooling under the RED are undermined by one key methodological shortcoming. This deficiency diminishes the comprehensiveness of the RED and incentivises Member States to promote less efficient technologies, while undervaluing the contribution of heat pumps.

By accounting for the energy harnessed to produce the useful heat, rather than the useful heat itself, the current metrics disproportionately credit the least efficient heating systems with generating the most renewable heat, as illustrated in (Figure 3). An electric heat pump (SPF = 3) producing 100 units of renewable heat gets credited with 100 units, despite using only 33 units of input energy, whereas a wood fireplace (50% efficient) gets credited with 200. The less efficient the device, the more renewable credits it receives for producing the same amount of useful heat.

It is also notable that because of the metrics used and the way electric resistance is considered the amount of useful heat drops to zero for this technology, which explains the significant drop-off in Figure 3.

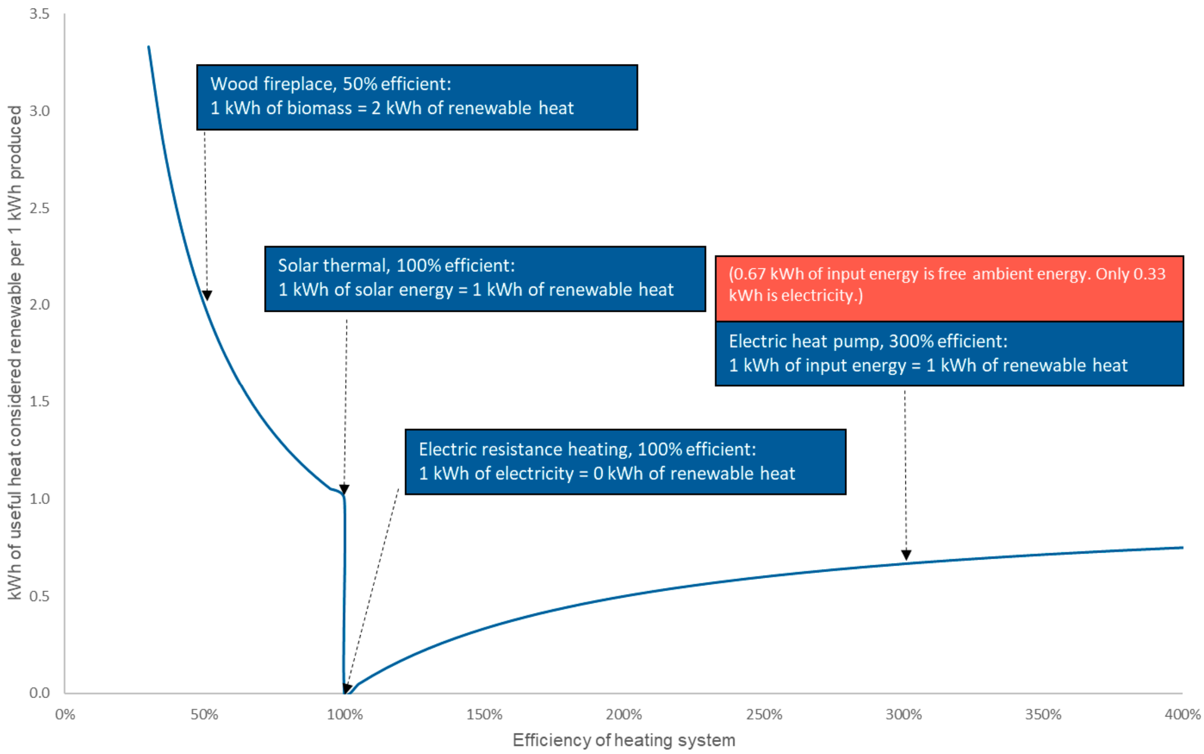

Figure 3. Renewable heat production in relation to heating system efficiency under RED.

4. Proposed Alternative Approach

The primary metric for assessing renewable heating and cooling consumption is useful energy. The goal of the RED should be to promote the adoption of efficient heating and cooling technologies that maximise useful energy output while minimising the input energy required.

To improve the existing methodology, the first step would be to align the consumption of "renewable heating and cooling" with the concept of useful energy produced from renewable sources. This would entail incorporating both the fuel consumption data (already available in energy statistics) and the average efficiencies of heating technologies deployed across Member States. Using these parameters, an estimate of the useful energy generated could be calculated.

The second step involves ensuring that the data on electricity used for heating and cooling is appropriately accounted for within the heating and cooling sector. Many Member States, such as France, already gather these values through statistical surveys, which can provide the necessary data to include electricity consumption in the calculation of renewable heating and cooling energy [25]. In these data, electricity consumption for space heating, sanitary hot water, cooking, and cooling is available. These figures can be combined with the average share of renewable energy in electricity consumption to calculate the renewable electricity used for heating and cooling.

In some Member States, such as France, existing energy statistics distinguish the electricity used specifically for heat pumps, enabling a more accurate calculation of the full contribution of heat pumps to renewable energy. In such cases, it is essential to revisit the definition of renewable energy from heat pumps as outlined in Annex VII of the RED to ensure it aligns with this more detailed accounting approach.

Rather than counting the final energy consumption of heating fuels, we propose considering the useful heat produced by each heating device. This approach ensures the full contribution of renewable energy from heat pumps is acknowledged and that efficient technologies are preferred by the metrics. The proposed redefinition is illustrated in

Figure 4. We also propose increasing the binding heating and cooling targets of 0.8 pp/year and 1.1 pp/year so that they reflect the needed contribution of the heating and cooling sector to reach the binding headline target of 42.5% by 2030 (with ambition for 45%).

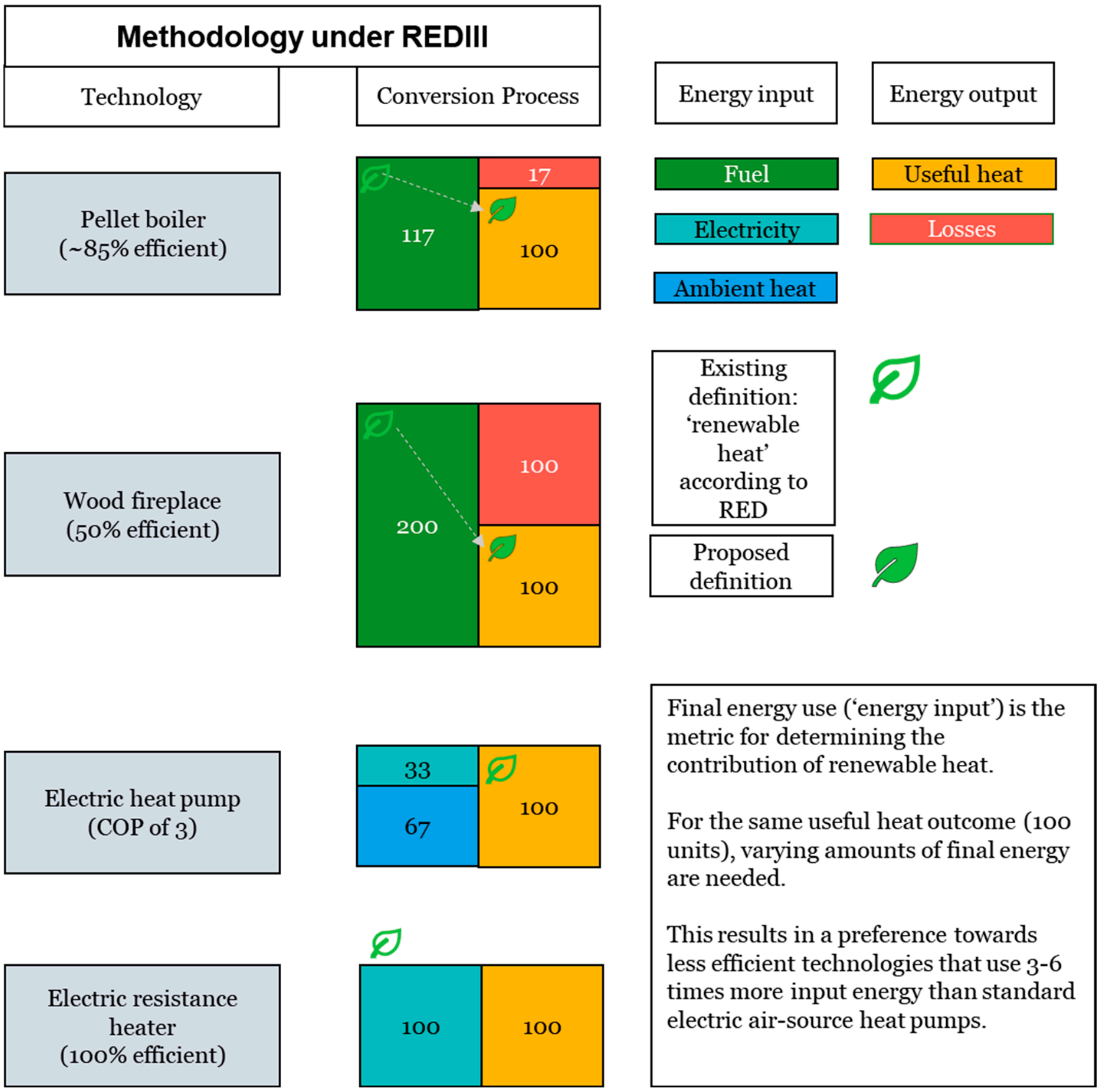

Figure 4. Proposed redefinition of renewable heat for specific heating technologies. This graphic is for illustrative purposes and assumes, for simplicity, that the electricity input is entirely renewable. In the European Union, approximately 40% of electricity was sourced from renewable energy in 2021.

5. Discussion and Policy Recommendations

The rapid deployment of efficient renewable heating and cooling technologies is essential to the European Union's strategy for reducing dependence on Russian fossil fuels and meeting its ambitious target of a 55% reduction in greenhouse gas emissions by 2030. To achieve these goals, the EU has established, and is currently revising, objectives to increase the use of renewable heating and cooling across Member States. However, the current metrics in the RED fail to fully incentivise the adoption of high-efficiency technologies and instead encourage the use of less efficient systems while undervaluing the contribution of more efficient devices towards achieving these critical targets.

For a more comprehensive and accurate understanding of renewable energy use in the heating and cooling sectors, it is imperative that the metrics assess technologies in terms of useful energy produced rather than solely focusing on fuel consumption. RED III did not address this essential aspect, missing an opportunity to improve the accuracy and relevance of the metrics in achieving the EU's energy and climate objectives.

Modifying these metrics may also necessitate a reassessment of the RED's targets, particularly in relation to the heating and cooling sectors. If the EU aims for a holistic and realistic assessment of its renewable energy use, an accurate and transparent statistical approach is essential to ensure that the targets are both ambitious and achievable. Without this, the renewable energy targets for heating and cooling may remain disconnected from the realities of energy efficiency in practice.

To better align the RED with the EU's broader energy and climate goals, the following adjustments should be considered:

- Amend Article 7(3) of the RED to calculate the useful energy produced, rather than focusing on the fuels consumed to generate it. This would provide a more accurate reflection of the renewable energy contribution from heating and cooling technologies.
- Mandate Eurostat to develop a consistent methodology for counting renewable electricity used for various services, including heating and cooling. This would encompass all forms of electricity used, such as that from electric resistance heating and heat pumps. To avoid double-counting, any renewable electricity used in heating and cooling should be removed from the calculation of the headline renewable energy share.
- Furthermore, it is important to note that the current methodology does not factor in the efficiency of heat production. This creates a situation where technologies requiring more input energy are not disadvantaged. A potential solution is the introduction of an "efficient heat" metric, which would evaluate the efficiency of renewable heat production by dividing the useful heat produced by the input energy required.

Implementing an efficient heat metric would represent a significant shift in the way renewable energy contributions for heating and cooling are calculated. For example, the least efficient technologies, such as a wood fireplace with a 50% efficiency rating, would be credited with 0.5 kWh of renewable heat for every 1 kWh of input energy. In contrast, a pellet boiler operating at 85% efficiency would receive 0.85 kWh, electric resistance heating would receive 1.0 kWh, and a heat pump with a COP of 3 would be credited with 3.0 kWh of renewable heat. The renewable heat credited would thus directly reflect the operational efficiency of each appliance.

Existing EU legislation, such as the Ecodesign Directive, already sets efficiency mandates for heating technologies but does not currently associate these mandates with renewable energy targets. By linking efficiency to renewable energy accounting, this approach would provide stronger incentives for the deployment of high-efficiency renewable heating and cooling technologies, ultimately supporting the EU's broader goals of decarbonisation and energy independence.

In conclusion, revising the metrics within the RED to incorporate these recommendations would create a more accurate and comprehensive framework for achieving the EU's renewable heating and cooling targets. This would help drive the transition to more efficient, renewable-based heating solutions, while reducing reliance on fossil fuels, particularly those from Russia, and contributing significantly to the EU's climate targets for 2030.

6. Conclusions

The way renewable energy is accounted for in the context of the European Union's renewable heating and cooling targets is often considered a technical issue that does not receive widespread attention. However, as this paper demonstrates, the metrics used to assess the contribution of specific technologies to these targets have significant implications for how EU Member States can effectively achieve their climate objectives.

Through this analysis, we identified that the current provisions in the RED inadvertently disincentivise the adoption of more efficient technologies. Under the existing methodology, less efficient heating systems result in higher reported consumption of renewable energy, which is credited towards meeting the EU's renewable heating and cooling targets. This misalignment undermines the European Commission's outlined pathways for achieving the climate targets, as it fails to prioritise the deployment of technologies that maximise energy efficiency and reduce overall energy consumption.

One of the primary issues lies in the fact that the RED currently focuses on fuel consumption as a metric for renewable heating and cooling, rather than on the useful energy produced by heating systems. This approach overlooks the efficiency of technologies and, by extension, their potential contribution to the EU's decarbonisation goals. Less efficient systems, which require more input energy to produce the same amount of useful heat, are thus unfairly credited with a larger share of renewable energy, distorting the overall picture of renewable energy use.

To address this issue, this paper proposed that the definition of renewable heating and cooling be revised to more accurately reflect the useful energy produced by these technologies. By focusing on the actual useful energy delivered, rather than the energy consumed to produce it, the RED would better align with the goal of decarbonising the heating and cooling sectors. This shift would ensure that technologies that optimise energy use, such as heat pumps, are more fairly credited for their contribution to renewable energy goals, thereby promoting their wider deployment.

At its core, this revised methodology would shift the focus from the energy inputs (fuels consumed) to the energy outputs (useful heat produced). This change would align the RED with the broader EU objectives of maximising energy efficiency and reducing carbon emissions across all sectors. Ultimately, adopting these changes would provide a more robust and effective framework for achieving the EU's renewable heating and cooling targets, thereby facilitating the decarbonisation of heating and cooling and contributing to the overall goal of meeting the 55% greenhouse gas emissions reduction target by 2030.

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Abbreviations

The following abbreviations are used in this manuscript:

COP	coefficient of performance
EU	European Union
kWh	kilowatt-hour
RED	Renewable Energy Directive

References

1. European Commission. *Stepping up Europe's 2030 Climate Ambition. Investing in a Climate-Neutral Future for the Benefit of Our People*; European Commission: Brussels, Belgium, 2020.
2. Steinbach, J.; Ragwitz, M.; Bürger, V.; Becker, L.; Kranzl, L.; Hummel, M.; Müller, A. Analysis of Harmonisation Options for Renewable Heating Support Policies in the European Union. *Energy Policy* **2013**, *59*, 59–70. [CrossRef]
3. Cansino, J.M.; Pablo-Romero, M.d.P.; Román, R.; Yñiguez, R. Promoting Renewable Energy Sources for Heating and Cooling in EU-27 Countries. *Energy Policy* **2011**, *39*, 3803–3812. [CrossRef]
4. Bertelsen, N.; Vad Mathiesen, B. EU-28 Residential Heat Supply and Consumption: Historical Development and Status. *Energies* **2020**, *13*, 1894. [CrossRef]
5. Rosenow, J.; Hamels, S. Where to Meet on Heat? A Conceptual Framework for Optimising Demand Reduction and Decarbonised Heat Supply. *Energy Res. Soc. Sci.* **2023**, *104*, 103223. [CrossRef]
6. European Commission Europe's 2040 Climate Target and Path to Climate Neutrality by 2050 Building a Sustainable, Just and Prosperous Society {COM(2024) 63 Final}—{SEC(2024) 64 Final}—{SWD(2024) 64 Final}. Available online: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2040-climate-target_en#documents (accessed on 9 May 2024).
7. Dekanozishvili, M. The Emergence of EU Renewable Energy Policy: Unpacking Policymaking Dynamics of RES-E Directive. In *Dynamics of EU Renewable Energy Policy Integration*; Springer International Publishing: Cham, Switzerland, 2023; pp. 61–100, ISBN 978-3-031-20593-4.
8. Dekanozishvili, M. Shaping EU Renewable Energy Policy Beyond 2020: REDII. In *Dynamics of EU Renewable Energy Policy Integration*; Springer International Publishing: Cham, Switzerland, 2023; pp. 155–210, ISBN 978-3-031-20593-4.
9. Fraboni, R.; Grazieschi, G.; Pezzutto, S.; Mitterrutzner, B.; Wilczynski, E. Environmental Assessment of Residential Space Heating and Cooling Technologies in Europe: A Review of 11 European Member States. *Sustainability* **2023**, *15*, 4288. [CrossRef]
10. Solorio, I.; Jörgens, H. *A Guide to EU Renewable Energy Policy: Comparing Europeanization and Domestic Policy Change in EU Member States*; Edward Elgar Publishing: Cheltenham, UK, 2017; ISBN 9781783471553.
11. Kranzl, L.; Hummel, M.; Müller, A.; Steinbach, J. Renewable Heating: Perspectives and the Impact of Policy Instruments. *Energy Policy* **2013**, *59*, 44–58. [CrossRef]
12. Schäfer, O. The Neglected Giant: Renewable Heating and Cooling in the EU. *Refocus* **2005**, *6*, 48–50. [CrossRef]
13. Holzleitner, M.; Moser, S.; Puschnigg, S. Evaluation of the Impact of the New Renewable Energy Directive 2018/2001 on Third-Party Access to District Heating Networks to Enforce the Feed-in of Industrial Waste Heat. *Util. Policy* **2020**, *66*, 101088. [CrossRef]
14. European Commission. *Proposal for a Directive of the European Parliament and of the Council Amending Directive COM(2021) 557 Final*; European Commission: Brussels, Belgium, 2021.
15. Regulatory Assistance Project; Ember; E3G; Bellona. *EU Can Stop Russian Gas Imports by 2025*; Regulatory Assistance Project: Brussels, Belgium, 2022.
16. Rosenow, J. Europe on the Way to Net Zero: What Challenges and Opportunities? *PLoS Clim.* **2022**, *1*, e0000058. [CrossRef]
17. Altermatt, P.P.; Clausen, J.; Brendel, H.; Breyer, C.; Gerhards, C.; Kemfert, C.; Weber, U.; Wright, M. Replacing Gas Boilers with Heat Pumps Is the Fastest Way to Cut German Gas Consumption. *Commun. Earth Environ.* **2023**, *4*, 56. [CrossRef]
18. European Commission. *REPowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy*; European Commission: Brussels, Belgium, 2022.
19. European Parliament, Secretariat of the Committee on Industry Research and Energy 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*; European Parliament, Secretariat of the Committee on Industry Research and Energy Compromise Amendments: Brussels, Belgium, 2022.
20. Eurostat Renewable Energy Statistics. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics#Almost_one-quarter_of_energy_used_for_heating_and_cooling_from_renewable_sources (accessed on 26 February 2025).
21. European Commission. *Directive 2018/2001 of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast)*; European Commission: Brussels, Belgium, 2018.
22. European Commission. *Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on Energy Statistics*; European Commission: Brussels, Belgium, 2008.
23. Martinopoulos, G.; Papakostas, K.T.; Papadopoulos, A.M. A Comparative Review of Heating Systems in EU Countries, Based on Efficiency and Fuel Cost. *Renew. Sustain. Energy Rev.* **2018**, *90*, 687–699. [CrossRef]

24. Gibb, D.; Rosenow, J.; Lowes, R.; Hewitt, N.J. Coming in from the Cold: Heat Pump Efficiency at Low Temperatures. *Joule* **2023**, *7*, 1939–1942. [CrossRef]
25. Ministère de la Transition Ecologique et de la Cohésion des Territoires. (2021). 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. Available online: https://www.statistiques.developpement-durable.gouv.fr/consommation-denergie-parusage-du-residentiel (accessed on 9 May 2024).