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PART 2/2

# COMMISSION STAFF WORKING DOCUMENT

# IMPACT ASSESSMENT REPORT

## ANNEXES

*Accompanying the*

**Proposal for a Directive of the European Parliament and of the Council**

**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) 2015/652**

{COM(2021) 557 final} - {SEC(2021) 657 final} - {SWD(2021) 620 final} -
{SWD(2021) 622 final}

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**ANNEX 1: PROCEDURAL INFORMATION**

*Lead DG, DEcide Planning/CWP references*

DG ENER, PLAN/2020/7536, 2021 Commission Work programme (under the "European Green Deal" headline ambition and as part of the "Fit for 55" package).

*Organisation and timing*

The review of RED II was announced in the European Green Deal Communication in December 2019.

An Inter Service Steering Group was established which involved the following DGs: JUST, RTD, ENV, ECFIN, AGRI, SG, CNECT, TRADE, COMP, BUDG, LS, CLIMA, DEFIS, DEVCO, EMPL, EEAS, ESTAT, IDEA, FISMA, GROW, JRC, MARE, MOVE, REFORM, REGIO, SANTE and TAXUD. A total of 3 meetings were held, on 19 October 2020, 7 December 2020 and 2 March 2021.

*Consultation of the RSB*

Two "upstream" meetings were also held with the RSB. The first one, on 24 November, was with DGs CLIMA, ENER and MOVE on the 'Fit for 55' package, to ensure coherence. The second, on 12 January 2021, was specifically on the RED II and EED revisions.

A draft Impact Assessment was submitted to the Regulatory Scrutiny Board (RSB) on 10 March 2021. Following the Board meeting on 14 April 2021, it issued a negative opinion on 19 April 2021. After careful consideration and integration of the Board's recommendations in the first opinion, a second improved Impact Assessment has been prepared and submitted on 28 April. After consideration of the resubmitted Impact Assessment the Board issued a positive opinion with reservations on 28 May 2021.

The two Board's recommendations of 19 April 2021 and 28 May 2021 have been addressed as presented below in the final Impact Assessment.

**RSB 1st Opinion of 19 April 2021**

*Recommended improvements and how they were addressed.*

***(1) The report should clearly define the scope of the initiative. It should specify how it aligns with the greenhouse gas reduction targets of the Climate Law, and how it follows or differs from the CTP modelling scenarios. On this basis, the report should make clear what are the open policy choices that this impact assessment aims to inform. The report should explain how the other 'Fit for 55' initiatives may affect the scope, choices or impacts of this initiative.***

- The Board's recommendation is very relevant and allowed to clarify the scope of this initiative and how it aligns and builds on CTP. To this effect, changes have been included in Chapter 5.2. to improve the text. The key findings of CTP and

how they were fine-tuned in the "Fit for 55" core scenarios are now explained in Annex 4A. Chapters 1 to 6 where reviewed, clarifying and adding references to how the proposed measures will contribute to the Climate Law objectives that now enshrine the increased climate target for 2030.

- The general objective has been reviewed and now makes reference to CTP but does no longer mention the explicit range for overall RES share as other ranges are discussed too in Chapter 5.
- References to interrelations with other Fit for 55 initiatives were added in the section on overall ambition (interlinkage with ESR, EED and ETS revision), in the transport section (regarding ETS, ReFuel Aviation and Maritime) and in the bioenergy sustainability section (interaction with LULUCF). A more thorough assessment of interactions is presented in Annex 4.
- Changes have been included in both Chapter 6 and 7 (efficiency assessment) to explain how core scenarios illustrate the possibility of relying more or less strongly on regulatory instruments (notably supporting renewables uptake as assessed in this IA).

***(2) The report should present a much more thorough justification for proposing some of the measures. In the absence of an evaluation, the report should provide evidence supporting the identified problems, in particular as regards the insufficient energy system integration and bioenergy sustainability criteria. The report should better explain which problem drivers cannot be addressed by market based instruments (the extension of the emissions trading system to transport and buildings and the Energy Taxation Directive) and require further regulatory intervention at EU level.***

- In order to address this important comment made by the Board, more clarity and distinction were provided between (1) the areas of action that are considered as essential and directly linked with the specific objectives (overall target, transport, H&C, system integration, bioenergy) and (2) those that are "flanking and enabling measures" (cross-border cooperation, offshore wind, industry – see Section 5.3.4), through an overall restructuring of options. For further improvement, a table explaining the new structure of policy options has been included in Chapter 5;
- Furthermore, the structure of options proposed was clarified and simplified, by deleting certain areas of action altogether (PPAs) and by streamlining the number of options within areas of action while reflecting better the intervention logic by checking the options against the problem definition and objectives;
- The key aspects of the Renewable Energy Directive today (Section 1.1) were also included and highlighted, the general objective of the IA was clarified and the interlinkages and the complementarity of the measures assessed with other instruments, notably carbon pricing, were discussed in more detailed (Chapters 5 and 6).

***(3) The report should clarify which measures are crucial to achieve the policy objectives and which are only 'nice to have'. Given that parallel initiatives also contain measures regulating industry, transport and buildings, the report should better substantiate the rationale for proposing additional measures and demonstrate that they are needed to reach the objectives.***

- The main options which are crucial to achieve the necessary contribution of RED to the CTP ambitions are in the field of heating and cooling, district heating and

transport, as well as to implement the key actions of the Energy System Integration Strategy as well as the Biodiversity Strategy. They were separated from "flanking and enabling measures" as explained in answer to point (2). While keeping the same level of ambition, the new structure aims at facilitating the reading by separating between crucial options and flanking and enabling measures. As also mentioned under the replies under point (2) **the structure of options** proposed was clarified and simplified by reducing the number of options *within* areas of action and better clarifying the rationale for the remaining ones, without sacrificing the comprehensive exposition of the options.

***(4) The value added of some of the measures, specifically from the EU perspective, needs to be better justified in the report. In particular, for measures relating to heating and cooling that are by their nature deployed at a local level, subsidiarity considerations need to be clarified. The report should also justify the need for proposing menus of measures that are to be implemented by Member States.***

- The above recommendation made by the Board led to re-work Chapters 3 and 7 in order to better describe the EU added value. Specifically in Section 3.3 it is explained that by acting at EU-level in combination with action at Member State level, barriers to public and private investments can be tackled more effectively. Notably, addressing the lack of coordination between various bodies at national level as well as improving administrative and technical capacity can incentivise cost-optimal deployment of renewables at city and community level, where issues such as heating, cooling and hot water use remain key and are not decarbonising rapidly enough.
- The section 3.3 was also improved by better explaining that simply setting targets at EU levels and leaving Member States complete freedom as to how to achieve them would not be an effective way to achieve the agreed targets, as has been recognised by the co-legislators when they agreed the specific measures in the current REDII and the Governance Regulation. It also risks causing distortions to the internal market, and would lead to a less effective preservation and improvement of the environment, one of the specific aims of Article 194 TFEU. All these measures, do not, however, impinge upon the important national prerogatives such as the Member State's right to determine the conditions for exploiting their energy resources, their choice between different energy technologies and the general structure of their energy supply.
- Section 7.5 on subsidiarity and proportionality was completely reworked to address the Board's recommendation, by including the arguments in relation to **subsidiarity** and **EU added-value**, across options. For H&C, the argumentation was added about the paramount need to act in this sector as it will carry the largest effort in terms of renewables deployment while keeping flexibility to Member States. The link with Chapter 3 was also re-enforced.
- Section 7.5 concludes that the balance between obligations and the flexibility left to the Member States on how to achieve the objectives is considered appropriate in the light of what is needed for the increased climate ambition.

***(5) The impact analysis for measures regulating bioenergy seems too narrow. The report should analyse the effects on the bioenergy sector resulting from the increasing demand for renewable energy sources and clarify assumptions, uncertainties and potential risks. In particular, this relates to sectors that are difficult to electrify (e.g. aviation and maritime transport). It should analyse to what extent the increased***

***demand for renewable energy could be satisfied from within the EU. The report should clarify whether the proposed sustainability criteria for biomass and the increased use of bioenergy (especially after 2030) are aligned to the Green Deal's 'do no harm' principle, in particular for air pollution. It could be clearer on potential trade-offs with the revised LULUCF, the EU's biodiversity strategy and the bioenergy sector, and how different interests are balanced.***

- To address this critical recommendation, a number of important changes and clarifications were introduced. The problem definition has been extended with additional reference to the recent findings of the JRC report on woody biomass for energy. As requested by the Board, the issue of air pollution is raised in section 2.3 and in 6.7.2.
- The policy options have been clarified and linked to the political commitments under the European Green Deal and the Biodiversity Strategy (and the associated JRC report on woody biomass for energy). The section on future biomass demand and supply has been significantly developed in particular in section 6.7.1 with additional information on structure and development of demand (figure 32), and highlighted the situation in Member States in the NECPs. More detailed information on the administrative impact has been added in section 6.7.3.
- The section on the problem definition and key drivers has been further elaborated to address air emissions associated to biomass combustion. In the section on the assessment of the policy options, the discussion of potential trade-offs and synergies with the revised LULUCF and EU Biodiversity strategy have been further developed in the coherence section in 6.7.4 (specific box on interrelation with LULUCF).

***(6) The report should complete the analysis of impacts. Modelling results should be complemented by a more thorough (qualitative or quantitative) assessment of the considered individual measures, drawing on other available evidence. The report should clarify who is affected and how. In particular, it should show how effects are distributed across Member State. It should revise the presentation of the comparison of options. It should always compare options against the baseline and adjust the scoring accordingly. Options should be systematically compared to all assessment criteria, based on the impact analysis.***

Further quantitative assessment was included under assessment of the measures wherever possible. Specifically, for heating and cooling (Sections 6.2.1.3) and district heating and cooling (Section 6.2.2.3) more studies available from literature were highlighted. In these sections, it was stressed that a coordinated infrastructure planning with more involvement of local and regional authorities could result in important economic savings and avoid issues of mis-planning and resulting inefficiencies. This policy option provides an enabling tool for higher ambition in renewable heating and cooling, and increases the effectiveness of other measures – also the carbon pricing. It also enables coordination with the Long-term Building Renovation Strategies (Article 2a of the revised EPBD) and the Comprehensive Heating and Cooling Assessments (Article 14 of the EED and Article 15(7) of REDII). For the MS, the operating cost would be limited to the

administrative costs to develop such global framework and the cost of pilot/demonstration projects[1]

- The analysis "who is affected and how" was included in Annex III.
- In revised Section 7.1, the effectiveness of the options was summarized for the specific areas of intervention, including the scoring adjustments as requested by the Board. In addition, dedicated sections were developed on Coherence (Section 7.3) and administrative and monitoring impacts (section 7.4) while discussing the latter across Chapter 6 with more details specifically for H&C( Sections 6.2.1.4) and DH&C(6.2.2.4) and in Annex 5.
- Impacts of certain options highlighted by the RSB, in particular bioenergy and certification were strengthened. In Annex 8, a specific example on impact on smaller installations producing electricity from woody biomass has been added.
- In some instances modelling results were used better, e.g. in Section 6.1.2.3 (distributional impacts) and in Section 6.6.1 as MIX-H2 scenario was fine-tuned and thus more useful for discussion of policy options.

***(7) Views of stakeholders, in particular the dissenting and minority views should be better reflected throughout the report, including on the problem definition, construction of options and the choice of the preferred option(s).***

- Additional references to stakeholder views (stakeholder boxes) were added to chapter 6 to reflect the Board's recommendation, and the views of different stakeholder groups were described in more detail, differentiating between business / industry, NGOs, public authorities or other groups. In some cases including in the section 5.6 on discarded options, a justification was added justifying why stakeholder views supporting an option that was eventually discarded were not considered.

***(8) The report should improve the presentation of the estimated costs and benefits of the preferred option(s) and include a more comprehensive overview in Annex 3. As far as possible, the report should quantify the expected increase in administrative burden***.

- Further quantitative analysis has been added, including on administrative costs in Chapter 6. Annex 3 has been updated and the analysis from the REFIT table moved under it.

***(9) The methodological section (in the annex), including methods, key assumptions, and baseline, should be harmonised as much as possible across all 'Fit for 55' initiatives. Key methodological elements and assumptions should be included concisely in the main report under the baseline section and the introduction to the options. The report should refer explicitly to uncertainties linked to the modelling. Where relevant, the methodological presentation should be adapted to this specific initiative. In particular, the report should clarify that the modelling results show the impact of the assumed overall ambition level of measures, instead of the effect of the specifically proposed measures.***

[1] Heat as a service project in Bristol example: ttps://es.catapult.org.uk/news/bristol-energy-is-first-uk-supplier-to-trial-heat-as-a-service/

- The methodological section (Annex 6) was harmonized with the methodology document accompanying Fit-for-55 initiatives of DG CLIMA as already for previous submission both texts had several items in common. The Annex is now clearer in explaining the common methodological approach in modelling.
- The use of modelling results are explained better in Section 5.2.: policy options on the level of targets are aligned with core scenario findings and core scenarios show the impact of all "Fit for 55" initiatives combined. With respect to the latter, the MIX-LD variant offers a possibility to isolate the impacts of revision of RED only. The variant is discussed in Chapter 6.1.2 and well as in Chapter 7.2.
- Finally, Section 5.5 shows how variants are used for assessment of certain options (notably MIX-H2 on RFNBOs promotion and MIX-GAP on Member States top ups for RES H&C shares) and explains that some policy options analysed in this impact assessment revolve around the type or way of implementation, and not the level of ambition of regulatory measures. Implications on Member States RES shares for the overall and H&C sector were also included in Table 12.

**RSB 2nd Opinion of 28 May 2021**

***1) The report should present a more thorough justification for proposing some of the measures. It should better explain which problem drivers cannot be addressed by market based instruments (e.g. the possible extension of the emissions trading system to transport and buildings and the energy taxation Directive) and require specific regulatory measures on renewable energy at EU level. It is not clear what problems the 'flanking and enabling measures' address. The problem description should be completed to cover the issues that these measures aim to tackle.***

- In order to address this relevant comment made by the Board, further improvements under the problem drivers were made to highlight the need to tackle non-market barriers in end use sectors complementing the action of carbon pricing. The rationale for 'flanking and enabling measures' to support the cost-effective achievement the overall renewable energy target in 2030 is also further explained.

***(2) The report should better justify why it is necessary to introduce lists of measures on heating and cooling and on district heating and cooling, which are inherently national or even local responsibilities. It should justify why it proposes to make it compulsory for each Member State to introduce two of the measures for heating and cooling. The report should clarify the status of the list of measures for district heating and cooling.***

- This important consideration raised by the Board has been fully taken into account. The text has been updated to reflect the possibility for Member States to choose between an extended list of measures without any compulsory measures. This would provide a tool box of measures and guidance in implementing the heat transition with full flexibility at national level. The latest design fully respects national and local diversities in conditions and starting points, and provide a clear framework for actors at all levels (national, regional, local) and of all types (from utilities and companies to municipalities to citizen consumers/prosumers). In addition, the district heating elements were

substantially improved not just on the current aspects of REDII in Chapter 1 but in all sections across the document, specifically Chapters 5 and 6.

***(3) The report does not sufficiently justify the addition of new options on electric vehicle charging infrastructure. It should specify the problem these options aim to address and explain why they cannot be tackled under parallel Fit for 55 initiatives, notably the revisions of the alternative fuel infrastructure Directive and the energy performance of buildings Directive. The assessment on this point needs to be reinforced to better support the choice of preferred option.***

- As recommended by the Board, the narrative and options on electric vehicle charging have been improved throughout the impact assessment to highlight better the problems and issues and how this revision, the AFID (Alternative fuel infrastructure directive) and the energy performance of buildings directive fit together in order to facilitate the electrification of the transport sector in the context of a integrated energy system. The assessment of the options was also re-enforced in all sections of the impact assessment to support the preferred option in Chapter 8.

***(4) The report does not sufficiently substantiate the lack of sustainability of bioenergy. It should better use available evidence to demonstrate why the current sustainability criteria are insufficient and possibly incoherent with the Biodiversity Strategy and the Land Use, Land-Use Change and Forestry Regulation (LULUCF). The current argument that the National Energy and Climate Plans (NECPs) do not sufficiently assess the impacts on LULUCF sinks and biodiversity is not convincing, as the modelling results show a substantial increase in demand for bioenergy only after 2030 (period not covered by the NECPs).***

- The problem definition was revised to highlight the links with the Biodiversity Strategy and LULUCF and in particular the requirement of the Biodiversity Strategy to minimise the use of whole trees. The problem description was extended to respond to the need to minimise the use of quality stemwood for energy production. Additional arguments were added why a targeted strengthening of the criteria, based on the improvements made by RED II in 2018, are necessary.

***(5) The report should strengthen the analysis of impacts of the proposed measures on air pollution, in particular those regarding the renewables target for transport and the use of bioenergy. When analysing the environmental impact of the increased use of bioenergy, the report should not only make the comparison with the current situation, but also with other possible renewable energy sources. While the initiative focusses on 2030 targets, the report needs to discuss the coherence of the various measures with the decarbonisation goal for 2050 and other long-term policies (e.g. zero pollution action plan).***

- Further references to the problem of air pollution were added in the section on problem definition, including on drivers and on the evolution of the problem, and in the chapter discussing the bioenergy options.

***(6) The report should present how measures have different impacts across Member States.***

- In order to address this important comment made by the Board, we disaggregated further the impacts on Member States and included fuel expenditure and electricity prices per (group of countries of) Member States. Furthermore key Member States results of core scenarios such as RES-E and RES H&C were included and will be further complemented in the form of technical report.

***(7) While the comparison of options from the effectiveness angle has improved in the revised report, the comparative assessment of efficiency, coherence and proportionality is not presented in a straightforward way. The report should present all criteria in a synthetic, tabular form that would allow a better comparison of the options against the baseline. The comparison should be more specific and go beyond the aggregated modelling results and beyond general statements on coherence or the level of administrative burden.***

- As suggested by the Board, in order to clarify further the options presented, the comparison of effectiveness was expanded to include, efficiency, coherence and proportionality in a consolidated manner. Furthermore, more clarifications were included beyond modelling results and table was re-worked to include MIX-H2 and highlight further MIX-LD results. The coherence and level of administrative burden sections in Section 6 were highlighted even further and cross-referenced with Section 7 which summarizes the assessment in the previous Section.

***(8) The report should transparently report on all stakeholder groups' views (including diverging ones) on critical issues (for example on sustainability criteria). It should clearly explain how concerns have been taken into account.***

- In particular in areas highlighted by the Board such as Heating & Cooling and the biomass sustainability criteria, the analysis of the stakeholder views was further fine tuned. In specific cases, references to stakeholder opinions were added in the summarising chapters 7 and 9, including when the preferred option did not follow the majority opinion by stakeholders. In the case of biomass, it should be highlighted that the opinions brought forward in the OPC and expressed during stakeholder consultations were very diverse.

***(9) The narrative on subsidiarity is not sufficiently nuanced in the report. The subsidiarity principle indicates that the EU may only intervene if it is able to act more effectively than EU countries at their respective national or local levels. Therefore, measures should be assessed from the point of view of being in conformity with the principle rather than whether the subsidiarity is impacted or not.***

- As the Board pointed out, the conformity with the subsidiarity principle has been highlighted further in the relevant sections, such as (district) heating and cooling when assessing the options especially on the measures at national or local levels and also in section 7.5. As mentioned in point 2 above, the specific sections on (district) heating and cooling were further improved throughout the whole text.

***(10) The report is far too long and should be shortened in a manner that ensures effective information for policy makers.***

- Further efforts were made to reduce the length of the document to keep the core elements of the assessment in the main document text, with additional information either shifted to the Annex or deleted if it did not provide clear added value.

*Evidence, sources and quality*

A study was commissioned from external contractors Trinomics to provide technical support for renewables policy development and implementation.

The impact assessment carried out for the CTP was also part of the analysis.

The Member States' National Energy and Climate Plans and the Commission's assessment and the 2020 Renewable Energy Progress Report also formed part of the evidence base.

In addition the following studies also fed into the impact assessment:

- Technical support for renewables policy development and implementation: enhanced efficiency through sector integration
- Renewable Cooling under the Revised Renewable Energy Directive
- Renewable Space Heating under the Revised Renewable Energy Directive
- Policy support for heating and cooling decarbonisation
- Regulatory and market conditions of District Heating and Cooling
- Potentials and levels for the electrification of space heating in buildings

- Renewable Heating and Cooling Pathways, Measures and Milestones for the implementation of the recast Renewable Energy Directive and full decarbonisation by 2050
- Technical assistance to assess the potential of renewable liquid and gaseous transport fuels of non-biological origin (RFNBOs) as well as recycled carbon fuels (RCFs), to establish a methodology to determine the share of renewable energy from RFNBOs as well as to develop a framework on additionality in the transport sector
- Simplification of Permission and Administrative Procedures for RES Installations
- Establishing technical requirements & facilitating the standardisation process for guarantees of origin on basis of Dir (EU) 2018/2001
- Technical assistance for assessing options to establish an EU-wide green label with a view to promote the use of renewable energy coming from new installations
- Assessment of the potential for new feedstocks for the production of advanced biofuels (ENER C1 2019-412)
- Support for the implementation of the provisions on ILUC set out in the Renewable Energy Directive N° ENER/C2/2018-462

- The use of woody biomass for energy production in the EU (JRC report, published in January 2021)
- Scoping study setting technical requirements and options for a Union Database for tracing liquid and gaseous transport fuels

## ANNEX 2: STAKEHOLDER CONSULTATION

The Inception Impact Assessment (Roadmap) was published for feedback from 3 August to 21 September 2020 and 374 replies were received. There were responses from stakeholders from 21 Member States and 7 non-EU countries. Most responses came from companies or business associations, followed by NGOs, anonymous and citizens. Most responses came from Belgium (with a high share of European business associations located in Brussels), followed by Germany and France. A vast majority of the contributions reflected a positive attitude towards some type of revision of the Directive. For transport, heating and cooling, and building sectors, respondents called for the increase of shares of renewable energy sources with the development of specific targets in each of those sectors. On bioenergy, a majority of respondents were opposed or called for the limitation of the use of forest biomass as an energy source. Respondents insisted also on the necessity of focusing on the development of renewable hydrogen technology. The industrial sector called for the use of guarantees of origins to certify renewable energy and low-carbon fuels. A more detailed report is set out below.

In addition, the Commission launched an online public consultation on 17 November 2020 for 12 weeks until 9 February, in line with the Commission Better Regulation rules. It contains multiple choice and open questions covering a wide range of issues on the revision of REDII. 39046 replies were received in total, although the vast majority of replies consisted of a standard reply to a single question (section 3.7.3) on the types of biomass permitted for bioenergy production, criticising the use of forest biomass. In terms of the other replies, an analysis is presented below…

Stakeholder views were also gathered in two workshops, the first held on 11 December with sessions on the role of renewables in 2030 on the way to a carbon-neutral economy, heating and cooling, transport, industry, electricity, bioenergy and certification. The workshop was attended by around 500 participants from various industries, trade associations, lobby groups, as well as government institutions.

On Monday 22 March, DG ENER (Units C1 and C2) organised a second stakeholder workshop in the context of the revision of the Renewable Energy Directive (2018/2011) which gathered close to 1000 registered participants. Stakeholders were also consulted in more specific fora such as the Gas Regulatory Forum (14-15 October 2020), expert workshops on the decarbonisation of heating and cooling (26 November 2020 and 5 February 2021) and the Florence Electricity Forum (7 December 2020).

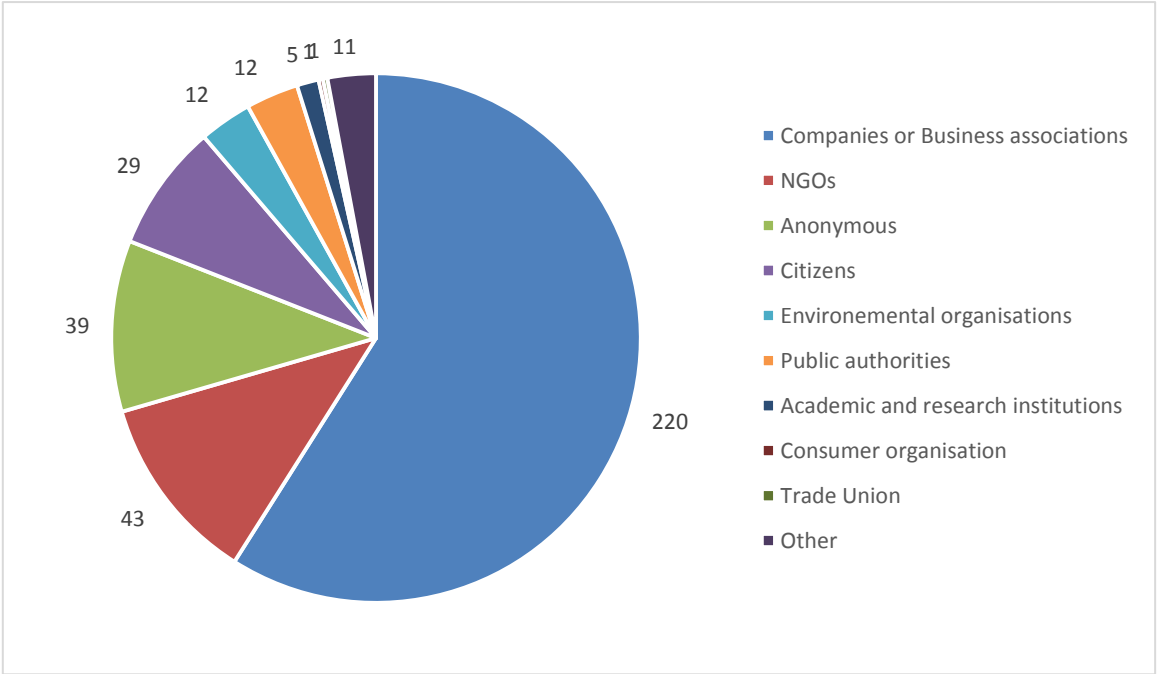
Consultations with the relevant sectoral social partners were held in a specific hearing on the “Fit for 55” package held by EVP Timmermans and Commissioner Schmit on 1st July 2021.

**Synthesis report: replies to the roadmap of the inception impact assessment on EU renewable energy rules**

The Commission consulted stakeholders on the inception impact assessment (Roadmap) on the revision of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources via the have-your-say website from 03 August to 21 September 2020. This consultation was open to the public.

The Roadmap had 374 replies, of which of which 220 came from companies or business associations, 43 from NGOs, 39 were anonymous, 29 from citizens (25 from the EU, 4 non-EU), 12 from environmental organisations, 12 from public authorities (mainly regional and local, only NL replied at ministerial level), 5 from academic & research institutions, 1from a consumer organisation, 1 from a Trade Union, and 11 "other". In terms of where the replies were from, 102 came from Belgium, mainly due to the presence of representation offices to the EU institutions in Brussels. Many replies also came from Germany (49), France (30), The Netherlands (20), Italy (19) and Sweden (16). A smaller proportion of replies came from other Member States such as Finland (10), Spain (10), Poland (9), Denmark (6), Ireland (5), Croatia (3), Hungary (3), Portugal (3), Slovakia (3), Czechia (2), Slovenia (2), Greece (1), Luxembourg (1) and Romania (1). This consultation also gathered replies from non-EU countries such as the United Kingdom (8), the United States (7), Norway (4), Canada (3), Brazil (2), Armenia (1) and Indonesia (1).

*Figure 46 - Overview stakeholder replies per sector*




*General*

A vast majority of the contributions reflected a positive attitude towards the increase of the **climate ambition** set in the European Green Deal and towards some type of revision of the Directive. A small number of stakeholders pointed out the negative impact such an **early revision of the Directive** could have for the stability of the regulatory framework

and investor certainty. A few were concerned about the **cost** of raising the targets for industry and consumers.

Almost a third of replies explicitly indicated that the revision should **raise the EU overall RES target**. Fewer stakeholders had a position on whether **national targets** should be binding or indicative, a majority of them supporting that they are binding. The **sectors** most frequently mentioned as appropriate for revision were transport, bioenergy, heating and cooling, buildings, certification of renewable and low carbon fuels, and permitting procedures.

Many respondents mentioned other EU legislative initiatives, which showed an awareness of the **inter-connectedness of RES with other policies,** such as the Energy Efficiency Directive, the EU Emissions Trading System, the Fuel Quality Directive, the Energy Taxation Directive, the Energy Performance of Building Directive, the Renovation Wave and the circular economy strategy.

*Transport sector*

**Biofuels, biogas, biomethane**
NGOs & academia (15 contributions) tended to call for a stronger limitation of **food and feed crops** used for biofuels, an increase of the **GHG threshold** to at least 70%, the abolishing of all **multipliers**, the revision of Annex IX to exclude **problematic feedstock** such as crude tall oil, pre-commercial thinnings, round wood, pulp wood and tree stumps) and want only domestic Used Cooking Oil to be used for biofuels in the EU.

Businesses & associations in the biofuels sector (64 contributions) called for the following list of measures: the increase of 14% **transport target**, the removal of the **cap on 1G biofuels**, the revision of **Annex IX** only to add new feedstocks, the removal of caps for all Annex IX feedstock, abolishing of **double counting** (although some voices want double counting to be maintained), and articles 29 – 31 should not be changed.

Several companies (19 contributions) called for stronger **support** for biogas / bioLPG / Dimethyl ether / biomethane in **transport**. Furthermore, some propose changes to Annex VI to account for recent developments in the **Anaerobic Digestion sector** and the introduction of a **minimum target for renewable gas**.

A few businesses and business associations called for the current set of rules to be continued. The **EV industry** (5 contributions) called for electrification to be favoured over biofuels (e.g. a minimum target for electrification of 3.5%) and an increase of the **transport target**. The City of Stockholm supported the use of biofuels as a successful strategy to reduce $CO^2$ emissions from the transport sector.

**Hydrogen, RFNBOs (synthetic (e-) fuels), low-carbon fuels & gas, recycled carbon fuels, gas**
NGOs & academia (9 contributions) called for the use of **green hydrogen** only where electrification is not possible (e.g. maritime, aviation) due to the low energy efficiency of the process compared to electrification. They insisted that hydrogen must only be sourced from **RES electricity** and not from Steam Methane Reforming (blue hydrogen). Furthermore, some called for **recycled carbon fuels** (RCF) to be excluded from the transport target.

Businesses & associations (23 contributions) called for the following list of measures: the removal of **criteria in recital 90**[2] as they are too restrictive, the establishment of **minimum quota for green hydrogen /e-fuels in transport** (e.g. 3.5%), the same treatment of **synthetic fuels** as electrification (same multipliers), the establishment of **sub-targets for synthetic fuels** in different sectors (e.g. chemicals, steel), the development of rules that support **RCFs** and counting of RCFs towards renewable transport target (other voices are against this).

The Ministry of Transport of the State of Baden-Württemberg called for an increased **transport target** and **sectoral sub-targets for hydrogen and e-fuels**. One recycling company is concerned that **RCFs** might undermine EU recycling policy.

**Maritime and aviation**
Businesses and business associations (8 contributions) insisted that **investments** in R&D are needed in the maritime and aviation sectors for successful decarbonisation. Furthermore, they called for **biofuels** to be redirected to sectors that are difficult to electrify such as maritime and aviation, for example through minimum shares or multipliers for SAF / shipping fuels.

*Bioenergy*

**Forest biomass**
Several NGOs, academics and citizens (20 NGOs, 15 citizens, and 2 academic institutions) are opposed to the use of **forest biomass** for energy, or called for its limitation by arguing that it leads to the destruction of forests, release of $CO_2$ and air pollution. The measures they called for are: the restriction of the **term "forest biomass"** eligible under the directive to residues and wastes, no use of **round wood** for energy purposes, the exclusion of **forest-derived biomass** from REDII, correct, science-based **accounting of emissions** from energy from forest biomass, and the **reduction of financial incentives and subsidies** such as renewable support schemes, zero accounting in ETS for forest biomass.

In contrast to NGOs and academic institutions, the IEA Bioenergy Technology Collaboration Programme and its scientists had a more favourable view towards the use of **forest biomass** for energy. They argued that energy from woody biomass can contribute to climate change mitigation, as long as carbon stocks are maintained or enhanced. Furthermore, they pointed to the importance of bioenergy with **carbon capture and storage (BECCS) negative emissions technology**.

Businesses and business associations (22 contributions) representing forest owners, the panel industry, the pellet industry and the power generation industry among others **did not want a revision of Articles 29 - 31** to ensure the predictability of legislation. Furthermore, some called to implement the **cascading use of wood principle**.

[2] Recital 90 outlines requirements such as temporal and geographical correlation between the electricity production unit with which the producer has a bilateral renewables power purchase agreement and the fuel production. It further explains that renewable fuels of non-biological origin cannot be counted as fully renewable if they are produced when the contracted renewable generation unit is not generating electricity. Finally, it explain the conditions when there is an electricity grid congestion and what should be understood under additionality.

On the topic of forest biomass certification, one certification scheme (FSC) called for bringing the **certification of forest biomass** for energy under RED II in line with its work on certification.

*Heating and cooling sector*

A large number of stakeholders supported the **review** of RED II, also highlighting the need to review the H&C articles, especially the RES H&C targets. Business organisations pointed out the importance of implementation and the use of non-legislative instruments.

Most stakeholders asked for a stronger H&C **target** of at least 50% share of RES by 2030 and called for a higher annual RES-H&C target of 3,1%. Stakeholders also called for making the H&C target in Article 23 binding. Several gas industry stakeholders called for quotas for green gas and renewable hydrogen and the inclusion of these new renewable fuels in the accounting for the RES H&C sub-target.

Several stakeholder mentioned the importance of updating the **target** accounting for RES H&C to include various renewable sources and fuels and waste heat, including for heat pumps. They also pointed out the need to extend Article 4 on support schemes to H&C overall or to specific technologies and fuels.

Several stakeholders called for prioritising **district heating networks** (DHC), together with buildings, to increase the uptake of renewables in HC. Better accounting for the DHC target and financial instruments are also called for. Stakeholders also called for encouraging the development of heating networks for sector integration benefits and flexibility.

Dedicated financial instruments are called for to support energy **infrastructures** carrying renewable electricity and renewable heat to buildings and industry as well as regulatory and financial support for sector integration.

Many stakeholders highlighted the importance of integrating **waste heat** better into the REDII framework, and to enable the use of local waste heat, but did not call for a specific waste heat target. Some of them argued that under Article 2(9) waste heat from any sources should be included and equated with renewables. Stakeholders also called for better supporting heat recovery from wastewater and sanitary hot water.

Several stakeholders highlighted the central role of **thermal storage** in facilitating the expansion of renewable heating and cooling, sector integration, flexibility and aggregation and called for financial and regulatory support for its integration into the renewable framework.

Several stakeholder asked for a clarification of the **definition of renewable energy** in Article 2 of REDII (inclusion of the heat content of waste water/sewage water, various green gases, geothermal, lithium).

Many stakeholder demanded a stronger and more predictable framework for **financial support** and instruments for renewable heating and cooling projects.

Many stakeholder mentioned the importance of **sector integration**, which to promote the combination of RES power, RES gas and RES heat, using also thermal energy storage, a solution well present, with low costs and with an enormous potential as an aggregator of different solutions.

Several stakeholder call for the **ban on fossil fuels** and stress that the future role of natural gas for heating must be clarified and general plan for climate friendly alternatives established.

Several gas industry stakeholders argued for a stronger focus on **renewable gases** such as biomethane, green hydrogen and synthetic gases.

Some stakeholders argued that it is important to use general **market instruments**, either instead of tighter regulation or complementing this.

Industry stakeholders of bioenergy sector highlighted the importance of **sustainable biomass and biomass fuels** in heating.

*Hydrogen*

A majority of stakeholders underlined the necessity of focusing on the development of **renewable hydrogen** technologies. However, some stakeholders claimed that hydrogen made from nuclear energy should be considered as clean hydrogen. A minority of stakeholders mentioned that the revision should encourage equally all different types of low-carbon gases, including blue hydrogen.

A majority of stakeholders asked for the appropriate **policies** to accelerate and scale-up the deployment of hydrogen technologies. They pointed out the need to enhance cost reductions for electrolysers and scale-up electrolyser production. They argued this can be supported through public procurement policies, long term contracts and investment support in the early phase. Some stakeholders specified the importance of energy system integration in the framework of the development of RES with hydrogen.

Some stakeholders called for a **dedicated support scheme** that should incentivise additional renewable electricity generation capacities to feed electrolysers that cover the essential needs for RE hydrogen.

A majority of stakeholders favoured REDII and other relevant EU legislation having a clear, consistent, and transparent European **definition** of renewable hydrogen across all European policies and laws. One stakeholder called for strengthening this definition to include only surplus renewable electricity, which would, in turn, require increased investments in renewable electricity installations.

Some stakeholders pointed out that specific **targets** for renewable hydrogen should be introduced in the transport and heating and cooling sectors. Among this group of responses, a few stakeholders called for a minimum quota of 5% green hydrogen and E-Fuels in the revision of the REDII use for industry. On the other side, a minority of stakeholders specified that technology specific targets should be avoided.

*Certification/ Guarantees of Origins*

Many respondents from the industrial sector called for the use of **guarantees of origins** (GOs) as the only tool to certify renewable energy and low carbon fuels that meet appropriate sustainability requirements.

The majority of the views expressed can be classified into three main categories: extending the GOs to other gases such as ammonia; extending GOs to all energy sources; and abandoning GOs as a certification system.

When it comes to hydrogen, a large number of stakeholders were in favour of a dedicated certification scheme that guarantees that all hydrogen used to contribute to the EU's renewable energy targets comes from surplus renewable electricity.

*Buildings, Permitting procedures, Renewables self-consumers and Renewable energy communities*

There was a strong call to increase the share of RES in buildings, and some stakeholders suggested specific targets (50% of RES share in buildings, ensuring that 40% of heating is provided by heat pumps in 2030 and 70% in 2050).

A number of respondents called for a clarification of the definitions of **renewable energy communities** (RECs) and **citizen energy communities** in the Internal Energy Market Directive (IEMD) and more consistency among Member States.

Stakeholders were in favour of not reviewing the related legislation while supporting a smooth and prompt transposition by Member States. In that sense, stakeholders were in favour of a transposition into the primary legislation to make it more effective. It was also recommended that Member States should properly assess barriers to self-consumption and RECs. A business association proposed the introduction of targets for the development of SCs and RECs.

## Report of the Open Public Consultation

### *Executive Summary*

The review of the Renewable Energy Directive 2018/2001/EU (RED II) is part of a wider review process to align various directives to the ambition of the European Green Deal, where the Commission proposed to increase the greenhouse gas reduction target of the EU from 40% to at least 50%-55% by 2030, and to achieve climate-neutrality by 2050. The review of RED II considers the interactions that it will have with other EU strategies, such as the Energy System Integration and the Hydrogen Strategies, the Renovation Wave Strategy, the Offshore Renewable Energy Strategy, and the EU Biodiversity Strategy for 2030.

As part of the open public consultation (OPC) process the European Commission launched a questionnaire to collect views and suggestions from stakeholders and citizens concerning the revision of the Directive 2018/2001 on the promotion of the use of energy from renewable sources (REDII). The questionnaire, which consists of 54 closed questions and 42 open questions, was uploaded on the EU Survey Platform at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001/public-consultation). The questionnaire was open for 12 weeks, from 17 November 2020 to 9 February 2021.

*Key results*

*Participants*

- The consultation attracted a total of 39,074 participants[3], the vast majority of which responded in a personal capacity (38,404) while the remaining 670 represented an

[3] The consultation initially received 39,046 submissions to the questionnaire. 6 responses were excluded from the analysis because these organisations provided double submissions (one response is kept for each

organisation[4]. Only four individuals stated they were not an EU citizen, while 54 organisations are not based in the EU;

- Among the organisations that participated in the questionnaire, the majority reported being business associations and companies (a total of 71%) while NGOs and environmental organisations represented 16% of the respondents;
- Concerning the participation of EU citizens, four countries (Spain, the Netherlands, Germany, and Sweden) submitted over 40% of the responses received, while the UK and the United States were the most represented non-EU countries;
- Central government or central agencies from 13 Member States participated in the survey: Belgium, Czechia, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Slovakia, Spain, and Sweden. Public Authorities at lower levels (regional and municipal) from France, Germany, Netherlands, Spain and Sweden also replied, and a further response arrived from the Norwegian Ministry of Petroleum and Energy;
- A large number of responses (38,313, 98%) came from a coordinated campaign that only answered questions 9.3 and 9.3.1 (concerning whether limits to the feedstock for biomass should be introduced, where participants from the campaign used an identical reply). During the analysis additional smaller coordinated responses groups were identified. Two further campaigns involved a total of 25 and 18 participants categorised as NGO and environmental organisations. The analysis of open-ended questions also identified 141 businesses participating in 28 separate coordinated campaigns involving 3 participants or more;
- Excluding the questions on biomass feedstock targeted by the large coordinated campaign, the first four questions of the survey are the most answered closed questions, while the open-ended questions with most answered is Q1.3.2, where participants were asked to explain why they think certain parts of RED II should be amended.

**First overview of results**

- 98% of participants state that renewable energy is either important or very important. The result is consistent across all stakeholders groups.
- RED needs to be modified to be more ambitious and prescriptive. There is a clear support for changes also among business organisations.
- Concerning what should change, the overall target and the target for transport are the two answers with the most votes. Other popular answers are provisions concerning low-GHGs fuels (sustainable low carbon fuels such as low-carbon hydrogen and synthetic fuels with significantly reduced full life-cycle greenhouse gas emissions compared to existing production), provisions to simplify procedures for developers and Guarantee of Origin requirements,. The associated open questions (what else should change) received many and broad answers. Emerging themes include the do-no-harm principle, the role of bioenergy, and mixed messages concerning the role of low-carbon options.
- All groups indicated a preference for an increased RES target, with 80 % supporting a level of the target of at least the level of the CTP (43% stating it should be in line with the CTP while 37% saying it should be higher). All groups expressed a very strong preference (64% or higher) for the target being binding at both EU and national level.
- Transport and H&C are the two sectors where additional efforts should be required, with most stakeholders groups selecting either one or the other as their most popular choice.
- The majority of participants (86%) are in favour of an increase in the target for renewables in transport, with 43% suggesting this should be more ambitious than the 2030 CTP, 34% that it should be as ambitious as the CTP, and 9% that it should be less ambitious.

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organisation). 9 questionnaire responses were added subsequently after they were submitted via email. There were 34 additional contributions (without questionnaire) via email, 9 of which from participants that had already submitted a questionnaire.

[4] 645 responded to the questionnaire and 25 provided additional contributions

- On H&C, the majority of participants indicate that the current indicative target of 1,3% yearly increase of renewables in heating and cooling installations should increase (67%) and that renewable electricity should be counted towards the target (79%). Overall, participants slightly prefer a non-binding H&C target at MS level (51% to 49%), with wide variation among categories.
- Overwhelming support for stricter biomass sustainability criteria is found with NGOs, environmental organisations and individuals. T Coordinated by NGOs, 38.313 EU citizens, with a similar reply to one question, highlighted the fact that a serious reform should occur in EU bioenergy policies in order to not undermine climate, air quality, and biodiversity objectives and the commitment to the Sustainable Development Goals.
- Not considering the contributions from the above campaign, participants think sustainability criteria for the production of bioenergy from forest biomass should not be modified by a small margin (56% no to 44% yes), with clear splits among different categories.

***Summary of results from Section I – General questions on the review and possible revision of RED II***

- EU citizens and all stakeholder groups are in favour of amending RED to be more ambitious, prescriptive and biding, targeting better some sectors that are currently lagging behind.
- The importance of renewable energy is clearly recognised (98% of participants state that renewable energy is either important or very important). The result is consistent across all stakeholders groups;
- RED needs to be modified to be more ambitious and prescriptive. There is a clear support for changes also among business organisations. Regarding what to change, and not taking into account the specific case of bioenergy, the overall target and the target for transport are the two answers with the most votes on this specific question. Changes to the overall target is the most popular answer across all groups except consumer organisations (which expressed more often a preference for the transport target). Other popular answers to what should be amended are: GO requirements, provisions concerning low-carbon fuels, and provisions to simplify procedures for developers. The associated open questions (what else should change) received many and broad answers. Emerging themes include the exclusion or restriction of bioenergy, the do-no-harm principle, and mixed messages concerning the role of low-carbon options;
- Transport and H&C are the two sectors where additional efforts are requested, with most stakeholder groups selecting either one or the other as their most popular choice;
    - All stakeholder groups indicated a preference for an increased overall RES target, with 43% stating it should be in line with the CTP while 37% saying it should be higher than the CTP. All groups expressed a very strong preference (64% or higher) for the target being binding at both EU and national level.

***Summary of results from Section II – Technical questions on Transversal Energy System Integration Enablers***

- Stakeholders opinion concerning energy system integration is less clear, with opposite views arriving from different stakeholders groups and with the lack of neat preferences for most of the various measures proposed to support better integration:
- Participants were asked to rate the importance of different measures to build a more integrated energy system. Overall, all options proposed are considered either important or very important, with RE in buildings scoring the highest (93% combined) and biogas/biomethane the lowest (70% of participants rated it important or very important). The energy efficiency principle should be reflected in RED by promoting the use of waste heat and minimising energy transformation;

- Electrification of energy consumption would be better supported by investing in transmission and distribution networks and by developing further interconnectors and fostering digitalisation;
- Both individual and professional participants expressed the view that non-renewable low-carbon fuels should not be promoted or should be promoted less. There is a mixed support for encouraging the use of hydrogen and e-fuels produced from hydrogen. The more popular single answer was that they should not be encouraged, but the majority of participants are favourable to these with some limitations;
- Concerning the type of support measures for RES and low-carbon fuels, participants expressed a preference for market based support schemes. Supply-side quotas (the least popular answer) are still supported by the majority (57%) of respondents. Further answers (with fairly neat majorities) indicate that Monitoring and certification systems should ensure that GHG emissions are fully taken into considerations, GOs should be extended to renewable fuels and low-carbon fuels and renewable hydrogen should be added to the cooperation mechanisms;
    - CCS should play a prominent role for industry and to generate negative emissions, but participants are split 50/50 concerning whether RED should be revised to encourage the uptake of CCS and CCU.

***Summary of results from Section III - Technical questions on specific sectors***

***Electricity***

- Concerning measures to tackle the remaining barriers for the uptake of renewable electricity, participants rated streamlining permitting procedures as the most appropriate and urgent, with fostering regional cooperation as the second. Additional comments suggested increased support for renewable energy communities and self-consumption and demand-side management measures. The promotion of regional cooperation could instead be promoted by strengthening connection infrastructure and removing barriers to cooperation;
- In order to promote the use of private renewable power purchase agreements, removing administrative/legal barriers is considered the more appropriate measure, followed by financial solutions/instruments. Additional measures suggested include the use of existing certification systems and the digitalisation of grid infrastructure;
    - A clear majority of citizens and organisations (60%) think that all public authorities should be obliged to buy green energy outright, and a further 24% think they should be obliged but subject to some limitations.

***Heating and cooling***

- Participants indicate that the more appropriate option to increase the uptake or RES H&C is the use of district heating integrating waste and renewable heat (94% indicated it is either appropriate or very appropriate) and increase in energy efficiency (93%). Renewable gas is the least chosen answer, but still attracted 71% of positive views. Other options proposed included System-wide integration and harmonisation across energy carriers, and promoting a broad portfolio of technological options;
- Overall, participants slightly prefer a non-binding H&C target at MS level (51% to 49%), with wide variation among categories. However, the majority of participants indicate that the target should increase (67%) and that renewable electricity should be counted towards the target (79%);
- Environmental organisations and NGOs are the two groups clearly against making the target mandatory, increasing it, or counting hydrogen and synthetic fuels towards the H&C target (majority of 70% in each of the three questions). Although no explanation is provided, from other answers is possible to assume that NGOs and environmental organisations fear that higher and mandatory targets would incentivise further use of biomass and synthetic fuels in heating and cooling;

- Participants expressed a mild preference for expanding the list of measures included in the directive (54% yes to 46% no) and similarly (53% yes to 47% no) on making all or some measures binding. The list of measures provided in the Directive should be expanded to give priority to solar and geothermal energy, expand details on waste heat and encourage climate-neutral and decentralised solutions;
- Participants are also divided concerning whether measures to increase the share of renewables in heating and cooling should binding: no 47%, yes 28%, yes but only some measures 26%;
- The measures more appropriate for increasing the share of renewable H&C are pricing instruments, guidance and mandatory heat planning;
    - Public authorities should be encouraged to identify renewable H&C potential by strengthening the obligation in Art. 14 and Art 15 and by requiring mandatory long-term strategies.

***District heating and cooling***

- Participants expressed a mild preference for a binding target for renewable energy in district heating and cooling (53% yes to 47% no) and for increasing the current target (51% yes to 49% no). Environmental organisations and NGOs are distinctly against both propositions (only group of stakeholders expressing this preference), a similar view expressed for the heating and cooling target, because of the effect such a target may have on demand for biomass;
- A clear majority of respondents to the associated open question (level of increase to the current district heating target) suggest an increase of 2 to 3 percentage points;
- The more appropriate measure to encourage the use of waste heat and cold by district heating and cooling networks are the requirement to encourage cooperation between industrial and service sector companies, and the requirement for authorities to prepare the necessary plans. Further suggestions from stakeholders at this regard concern requiring economic and technical feasibility, and no obligation to use waste heat;
- Participants expressed a clear preference for strengthening third party access (68%), consistent across all groups. This is so to reduce the power of monopolies, increase competition and efficiency;
    - Participants also think that consumers rights would be strengthened by improved information on energy performance and renewable share and increased price transparency, while all measures proposed to support system integration are similarly rated (between 92% and 94% of participants rated them as either appropriate or very appropriate).

***Buildings***

- Participants think that Member States should require minimum RES share in new and renovated buildings (78% overall in favour), and 37% suggest a RES share of 50% or higher. Participants clarify in the associated open question that RED should introduce a gradual approach with additional limitations;
- Participants ranked simplifying permitting and administrative procedures as the measure that would be most appropriate to facilitate the phasing out of fossil fuels, followed by strengthening consumer information and accessibility of measures;
    - All measures proposed to improve the replacement of heating systems were rated either appropriate or very appropriate, with combined approval ranging from 95% to 81%. Information campaigns is considered the most appropriate option.

***Industry***

- The majority of participants are in favour of a RES obligation for industry, either on industry in general (55%) or to specific industries (12%). A substantial share (30% to 40% of those who answered the associated open questions think that sectors already subject to the EU-ETS should be excluded from the target and that obligations should be accompanied by financial support;

- Measures more appropriate to encourage RES take up in industry are the simplification of the permitting and administrative procedures, and minimum shares in the national building stock, but all measures proposed are considered appropriate by at least 79% of participants.
-

***Transport***

- The majority of participants (86%) are in favour of an increase in the target for transport, with 43% suggesting this should be more ambitious than the 2030 CTP, 34% that it should be as ambitious as the CTP, and 9% that it should be less ambitious. NGOs and environmental organisations are the only category where the most popular answer is no increase to the transport target (with 33% of answers), mostly due to concerns with increase in biofuel use that may be incentivised by a higher target. Common observations from stakeholders concern the removal of multipliers and the focus on some modes of transport such as road and aviation (both mentioned by around 25% of responses to the open question);
- Participants think Member States should not count other low carbon fuels (such as low carbon hydrogen) towards the target (45% yes to 55% no), but also think that these fuels should be encouraged (79%). Among the types of low carbon fuels, the most chosen are advanced biofuels and other fuels produced from biological waste and residues (293 responses) and renewable hydrogen and renewable synthetic fuels (292 responses). Participants further elaborated on the types of renewables and low carbon fuels that should be specifically promoted by referring also to electrification/batteries and suggesting the exclusion of low-carbon fossil fuels as these would compromise RED;
- An obligation on fuel suppliers should promote liquid renewable fuels, renewable electricity and gaseous renewable fuels, with relative disagreement between stakeholders groups. In the associated open question (which types of renewable and low carbon fuels can be best promoted by an obligation on fuel suppliers), renewable electricity is the option with most mentions and the fuel obligation should be based on GHG emissions targets.
- An additional target would be the most appropriate to encourage the use of hydrogen and hydrogen-derived synthetic fuels in transport, while renewables in general would be encouraged by ensuring the availability and interoperability of public charging infrastructure and the support to the installation of domestic chargers.

***Bioenergy sustainability***

- Bioenergy sustainability attracted strong views throughout the questionnaire in related questions, and Q9.3 and Q9.3.1, on limits to the type of feedstock allowed, received 38,786 answers, of which 38,313 thorough a coordinated campaign5. The campaign chose not to answer the other questions concerning bioenergy sustainability, but the sentiment towards bioenergy is unambiguous;
- Participants think sustainability criteria for the production of bioenergy from forest biomass should not be modified by a small margin (56% no to 44% yes), with clear splits among different categories.6 Overwhelming support for stricter criteria is found in NGOs/environmental organisations and individuals;
- A 50-50 split is instead found concerning the extension of criteria to installation below 20MW for solid biomass and 2 MW for biogas;
- The question whether there should be limits to the type of feedstock used for bioenergy production under RED II was answered by 38,786 participants, with 99% stating that RED should be changed to remove biomass from the list of renewable resources, limiting the use for bioenergy to locally-available waste and residues, and that this should be accompanied

[5] www.stopfakegreen.eu, a network of ca 130 environmental and other organisations, also active in the public debate on taxonomy

[6] It should be noted that this split does not take into account the coordinated replies mentioned above as the campaign participants did not reply to this question.

by a moratorium or a cap on the total amount of solid biomass in electricity and heating, by an accelerated phase-out of high ILUC risk fuels, and by the removal of incentives for bioenergy;

- Excluding the responses provided through the coordinated campaign, most responses provided on behalf of organisations still indicate that the criteria should be amended in some other way. Businesses and others are the only categories with small majority for no change (53% and 50%);
- The most popular answer to the question concerning the extension of GHG criteria was NO (232 answers). A lower number of responses indicate that the threshold should be increased (81), that the criteria should be extended to existing installations (72) or that other limitations should be introduced. These additional limitations are suggested in the associated open question, where participants predominantly suggested stricter GHG criteria. However, often the message is about the appropriateness of the use of bioenergy in general, and considering biogenic emissions rather than supply chain only.;
- Concerning whether the energy efficiency requirements should be made more stringent, the majority of answers (186) are in favour of an amendment (indicating that it should be extended to plants lower than 50MW (103 answers) or that the requirement should be higher (83 answers)). The remaining 167 participants are contrary to a change to the requirement.

**Report of the 1st Stakeholder workshop 11 December 2020**

*Executive Summary*

On 11 December 2020, the European Commission, DG Energy, held an online workshop in the context of the work to revise Directive 2018/2001 on the promotion of the use of energy from renewable sources. The revision aims to ensure that RES cost-effectively and sustainably contribute to at least 55% GHG emissions reduction in 2030, in line with the Climate Target Plan (CTP). This means reaching a 38% to 40% share of RES in 2030. The workshop was part of the wider consultation process on the revision of the Directive, launched on 17 November 2020. The main consultation documents are available online (at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001/public-consultation) and the consultation remains open until 9 February 2021.

The workshop agenda included 32 external speakers in seven sessions. Each session was coordinated by an official from DG Energy, following a loose script previously agreed with the contractor's project team. The workshop also included an opening session from Ditte Juul Jørgensen, Director-General, DG Energy and closing remarks from Paula Abreu Marques, Head of Unit, Renewables and CCS Policy, DG Energy.

The event was organised with the support of Trinomics which provided technical and content support to DG Energy. Over 699 people from over 250 different organisations registered for the workshop. During the day of the workshop, 443 people connected via the Zoom platform for an average of 4 hours and 10 minutes.

*Overview of the event*

The stakeholder meeting for the revision of Directive 2018/2001 on the promotion of the use of energy from renewable sources (REDII) was held on the 11 December 2020 as part of a wider consultation process. The process includes a questionnaire open to any

individual and organisation (available online at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001/public-consultation) and a second stakeholder workshop, to be held in spring 2021 (probably March tbc).

The workshop was organised by Trinomics as part of the contract ENER/ C1/2020-440 for Technical support for RES policy development and implementation: delivering on an increased ambition through energy system integration.

*Agenda*

The workshop was organised in seven sessions, split between morning and afternoon. As part of the agenda, Ditte Juul Jørgensen, Director-General at DG Energy, and Paula Abreu Marques, Head of Unit for Renewables and CCS Policy, also from DG Energy, provided introductory and concluding remarks, respectively.

The seven sessions covered the main areas of REDII, with session 1 providing the wider context for the need of renewable energy to achieve EU climate objectives. Each session was moderated by a DG Energy official responsible for the topic and gave ample space to the contributions from the panellists. The format of the event was agreed so that it would give maximum exposure to stakeholders' opinions and foster a debate among them. The event ran from 10.00 to 18.00, with a 1.15-hour lunch break.

*Figure 47 - Agenda stakeholder workshop (morning)*

| | **Agenda item** | **Moderator** | **Panellists** |
|---|---|---|---|
| **10:00** | **Opening and introduction** | **Ditte Juul Jørgensen,** *Director-General,* DG Energy, European Commission | |
| **10:15 – 11:15** | **Session 1** The role of renewables in 2030 on the way to a carbon-neutral economy | **Paula Abreu Marques,** *Head of Unit for Renewables and CCS Policy,* DG Energy, European Commission | • **Dolf Gielen**, *Director,* IRENA Innovation and Technology Centre<br>• **Günter Hörmandinger**, *Deputy Executive Director,* Agora Verkehrswende<br>• **Philipp Offenberg,** *Program Manager,* Europe at Breakthrough Energy<br>• **Simone Mori,** *Head of Europe, Executive Vice President,* Enel |
| **11:15 – 12:15** | **Session 2** Renewable energy in Heating and Cooling, Buildings and District Heating | **Eva Hoos,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Brian Vad Mathiesen,** *Coordinator of Heat Roadmap Europe*, Aalborg University<br>• **Andrej Jentsch**, *Operating Agent,* IEA Technology Collaboration Programme on District Heating and Cooling, including Combined Heat and Power<br>• **Patrik Pizinger,** *Mayor*, City of Chodov, Czech Republic<br>• **JP Prendergast,** *Chairman,* Claremorris and Western District Energy Co-Operative<br>• **Philippe Dumas**, *Secretary General,* EGEC |
| **12:15 – 13:15** | **Session 3** Renewable energy in transport | **Bernd Kuepker,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Paul Durrant**, *Head of End-use Sectors & Bioenergy,* IRENA<br>• **Geert Decock,** *Manager, Electricity and Energy*, Transport & Environment<br>• **Gloria Gaupmann**, *Chair of the Advanced Biofuels Coalition, & Head of Public Affairs, Technology & Innovation,* Clariant<br>• **Simon Bergulf,** *Director of regulatory affairs,* Maersk<br>• **Maarten Van Haute,** *Alternative Fuels Officer,* Q8 |
| **BREAK (1hr 15min)** | | | |

*Figure 48 - Agenda stakeholder workshop (afternoon)*

| | Agenda item | Moderator | Panellists |
|---|---|---|---|
| **14:30 – 15:15** | **Session 4** Renewables in industry | **Ruud Kempener,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Martin Porter**, *Executive Chair,* CISL Brussels<br>• **Peter Botschek,** *Director of Climate Change and Energy,* CEFIC<br>• **Aurelie Beauvais,** *Deputy CEO and Policy Director,* SolarPower Europe<br>• **Mikael Nordlander,** *Head of R&D portfolio Industry Decarbonisation,* Vattenfall AB |
| **15:15 – 16:00** | **Session 5** Measures for a further uptake of renewables in electricity | **Antonio Lopez-Nicolas,** *Deputy Head of Unit, Renewables and CCS policy,* DG Energy, European Commission | • **Bruno De Wachter**, *Convenor,* Working Group Market Design and RES of ENTSO-E Market Committee<br>• **Giles Dickson,** *Chief Executive Officer,* WindEurope<br>• **Dirk Vansintjan**, *President of the European federation of citizen energy cooperatives,* REScoop<br>• **Hélène Lavray,** *Senior Advisor - Renewables & Environment, Energy Policy, Climate & Sustainability - 2030 Framework Lead,* Eurelectric |
| **16:00 – 16:45** | **Session 6** Bioenergy sustainability | **Giulio Volpi,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Uwe Fritsche,** *Task Leader of IEA Bioenergy Task: Deployment of biobased value chains,* IINAS<br>• **Robert Matthews,** *Programme Group Manager,* Forest Research<br>• **Linde Zuidema,** *Forest and Climate Campaigner,* Fern<br>• **Jean-Marc Jossart**, *Secretary General,* Bioenergy Europe<br>• **Lotta Heikkonen**, *Forest Policy Advisor,* Confederation of European Forest Owners |
| **16:45 – 17.30** | **Session 7** A European system for certification of renewable and low-carbon fuels, including hydrogen | **Galin Gentchev,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Jorgo Chatzimarkakis**, *Secretary General,* Hydrogen Europe<br>• **Peter Styles,** *Executive Vice Chair,* EFET Board<br>• **Sascha Wüstenhöfer**, *System Manager,* ISCC International Sustainability and Carbon Certification<br>• **Javier Castro,** *Business Development Carbon Management Service,* TÜV SÜD Industrie Service<br>• **Sacha Alberici,** *Managing Consultant,* Guidehouse |
| **17:30** | **Concluding remarks** | **Paula Abreu Marques,** *Head of Unit, Renewables and CCS Policy*, DG Energy, European Commission | |

### *Attendance*

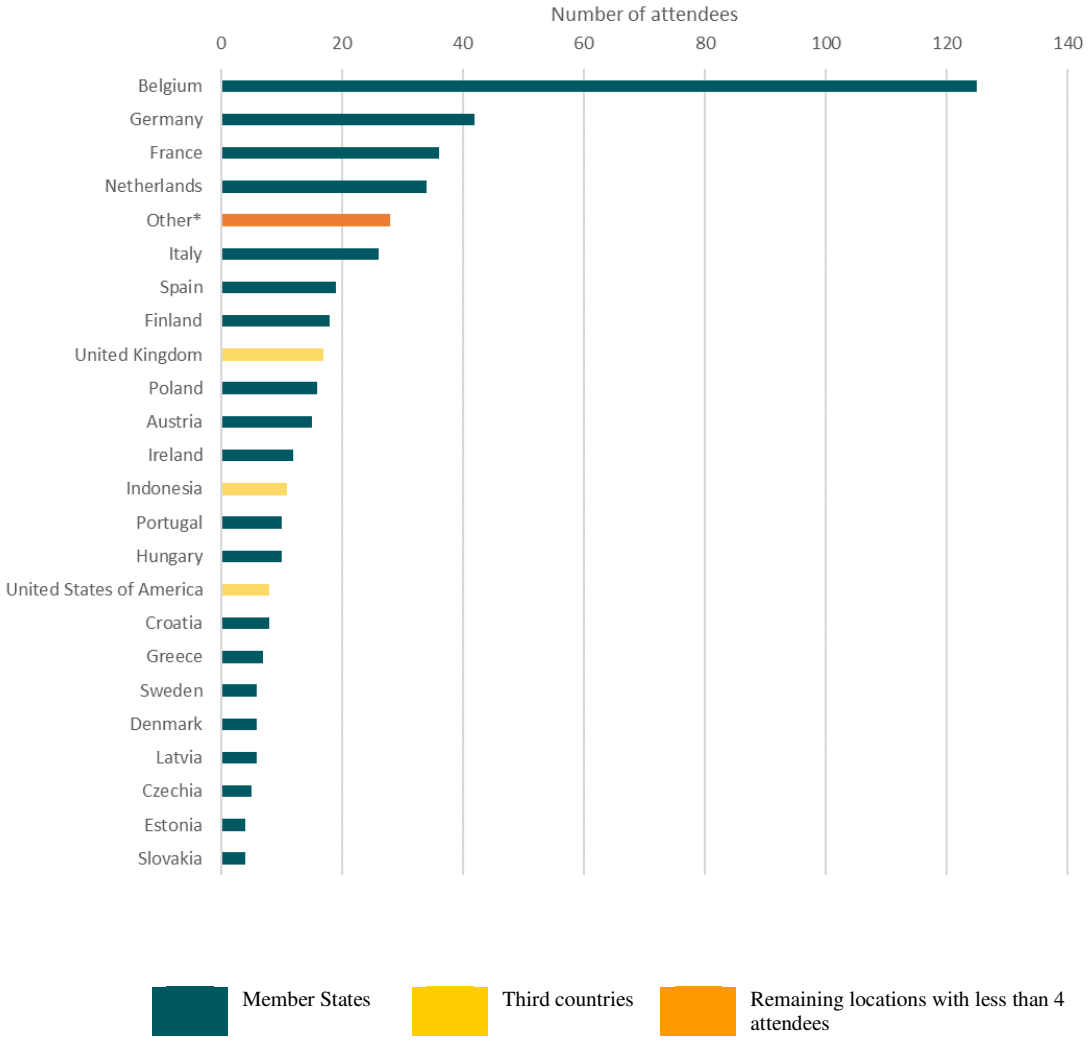
A total of 699 people registered for the event via the link provided and by sending a request via email. Of these, the total number of attendees was 495, of which 52 were moderators, panellists, and project team members. The remaining 443 participants were public audience. The attendance rate (share of registered people that connected to the workshop on the day compared to the total number of registrations) is 74%. On average, each attendee stayed logged in for 4 hours and 10 minutes, with several participants logging in and out multiple times.

The figure below shows the number of active connections throughout the day of the workshop. The dip in the graph between 13:25 to 14:45 is the break period. Generally, attendance was higher in the morning session than in the afternoon session and peaked at just under 350 participants.

*Figure 49 - Number of active connections*

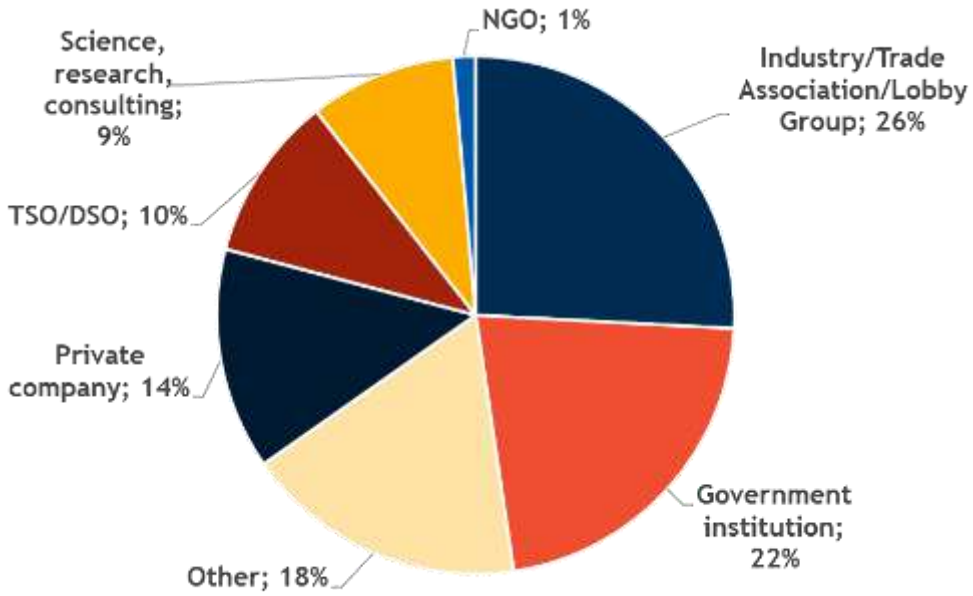

Most of the workshop participants were from within the EU, with the majority connecting from Belgium, followed by Germany, France, and The Netherlands. The high number of connections from Belgium reflects the number of lobby groups based in Brussels (bearing in mind this analysis excludes attendees registered with a @*ec.europe.eu* domain). Non-EU countries, such as the United Kingdom, United States of America and Others are highlighted in yellow and orange in the figure below

*Figure 50 - Location of participants (excluding participants from European Commission)*



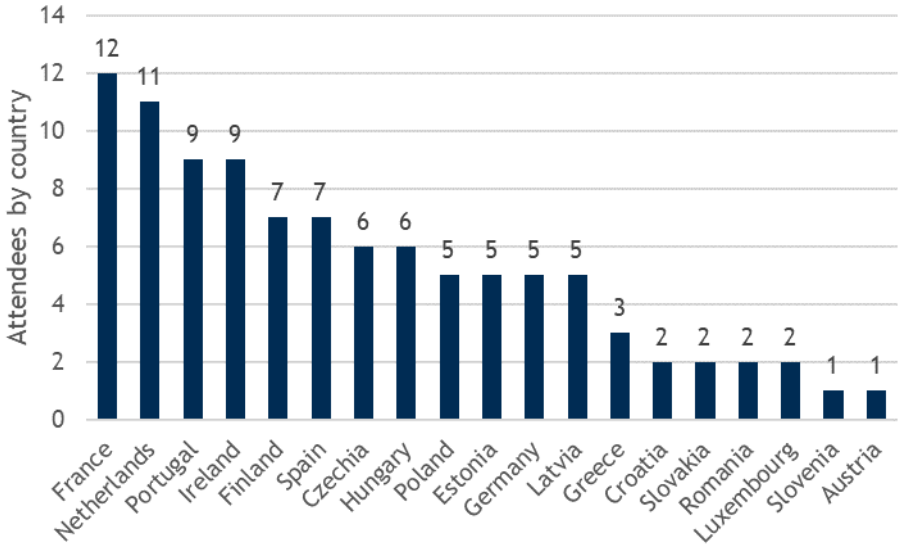

About half of the participants of the workshop came from various industries, trade associations, lobby groups (26%), as well as government institutions (22%), which includes officers from the European Commission. A large group of stakeholders came from private companies (14%), which was followed by Transmission and Distribution System Operators (10%), science, research and consulting companies (9%) and NGOs (1%). Furthermore, 18% of stakeholders fell under the category of "other", this category encompasses stakeholders such us publicly-owned companies, utilities, private individuals and other stakeholders which did not clearly fall under any of the other categories.

*Figure 51 - Affiliation of participants (including participants from European Commission)*




Among the 100 attendees classified as belonging to governmental organisations (central government and other governmental bodies, excluding EU institutions but including the permanent representation in Brussels), the countries with the most representatives were France and the Netherlands. No representatives attended from the governments of Bulgaria, Italy, Lithuania, Cyprus, Denmark, Malta, Romania, and Sweden.

*Figure 52 - Government representatives by country (excluding participants from European Commission)*

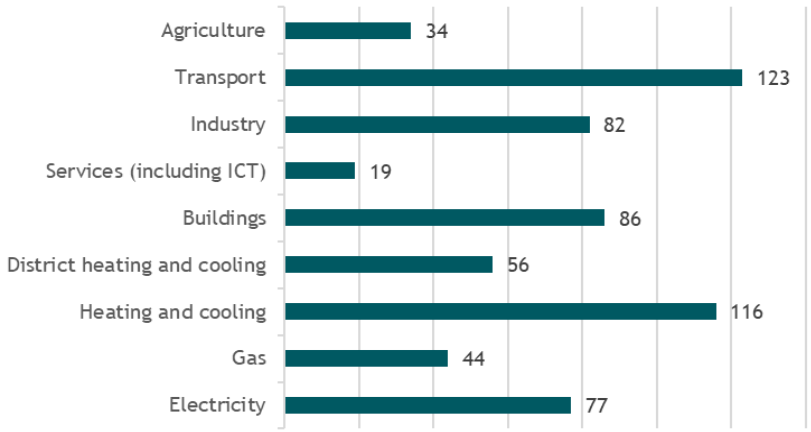


*Polls*

A total of 12 polls were launched during the workshop, one or more per session except for Session 3 (based on the deliberate design of the session). The participants were given about 1 minute for each question to submit their responses. The results of the polls are presented below.

*Session 1 The role of renewables in 2030 on the way to a carbon-neutral economy*

*Figure 53 - In which sectors do you think additional efforts to increase the use of renewable energy are most needed for a potentially higher renewables target for 2030? (n=215, multiple answers possible)*

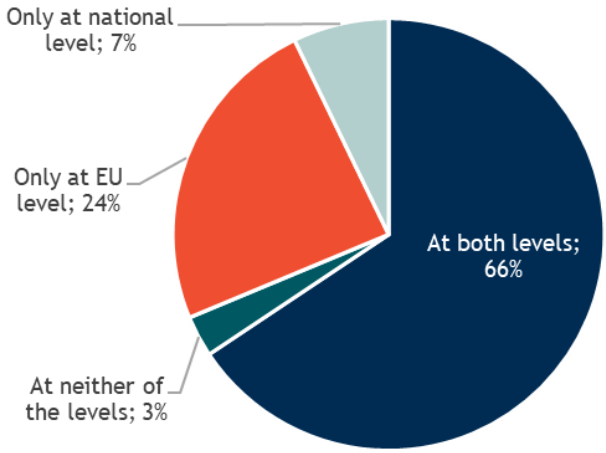



As shown in the figure above, the top three sectors where additional efforts are required to meet a potentially higher renewables target for 2030 are:

- **Transport sector** (123 votes)
- **Heating and cooling** (116 votes)
- **Buildings** (86 votes)

These are followed by: industry (82 votes), electricity (77 votes) and district heating and cooling (56 votes). The sector with the lowest number of votes was services including ITC (with 19 votes).

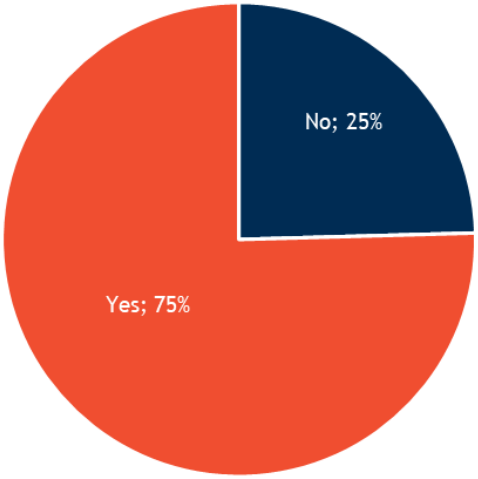
*Figure 54 - Should the overall renewable target be binding at EU level or at national level? (n=195)*



The figure shows that most of the respondents think that the overall renewable target should be **binding at both the national levels**, **as well as the EU level** (128 votes, 66% out of 195 votes). The answer with the second highest number of votes was "only at EU level". Only 3% of respondents think that the renewable targets should not be binding.

*Session 2 Renewable energy in Heating and Cooling, Buildings and District Heating*

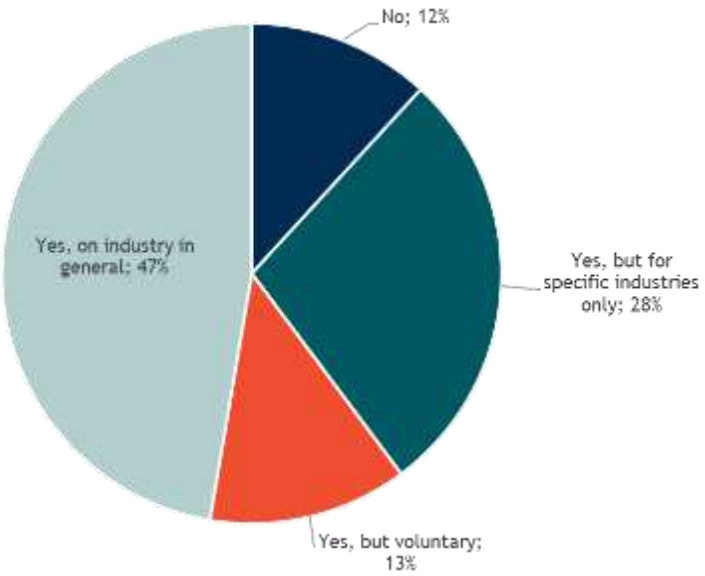
*Figure 55 - Should the current indicative target of 1.3 pp (or 1.1 pp, if waste heat and cold is not used), annual average increase of renewable energy in heating and cooling set for the period of 2021-2030 in Article 23 become a binding target for Member State*




Most of the respondents (85 votes, 75% out of 114 votes) think that the current indicative target of achieving a 1.3 ppt annual average increase in renewable energy in heating and cooling set for the period of 2021-2030 in Article 23 **should become a binding target for Member States**.

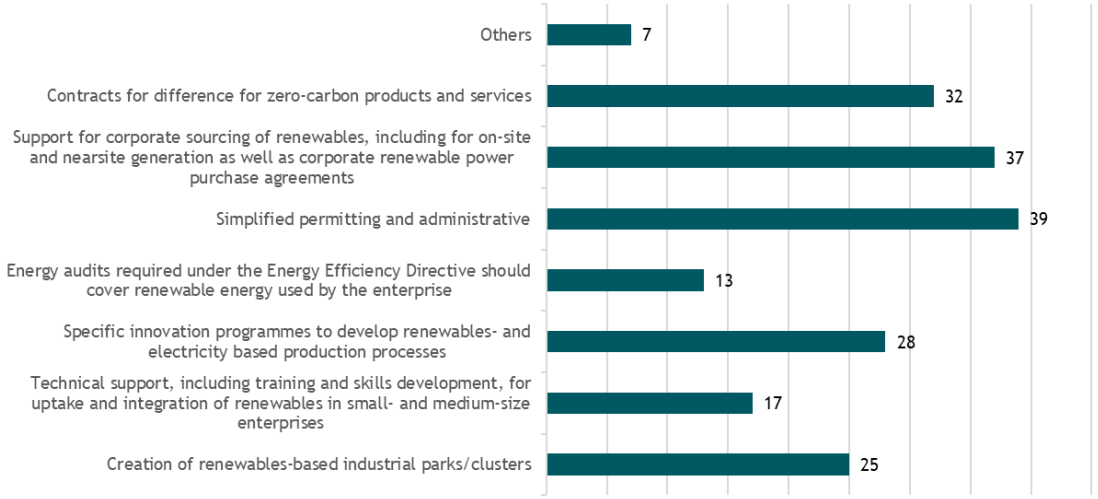
*Session 4 Renewables in industry*

*Figure 56 - Do you think there should be an obligation on certain industrial sectors to use a minimum amount of renewable energy? (n=93)*



Most respondents (43 votes, 47% of 93 votes) think that there should be an obligation on the **industry sector in general** to use a minimum amount of renewable energy. This answer was followed by 28% of respondents that specific industry sectors should have that obligation. Whereas 13% of respondents thought that such obligations should be voluntary, 12% thought there such be no such obligations.

*Figure 57 - Which of the following additional measures to encourage the use of renewable energy in industry do you find appropriate? (n=78, multiple selection possible)*

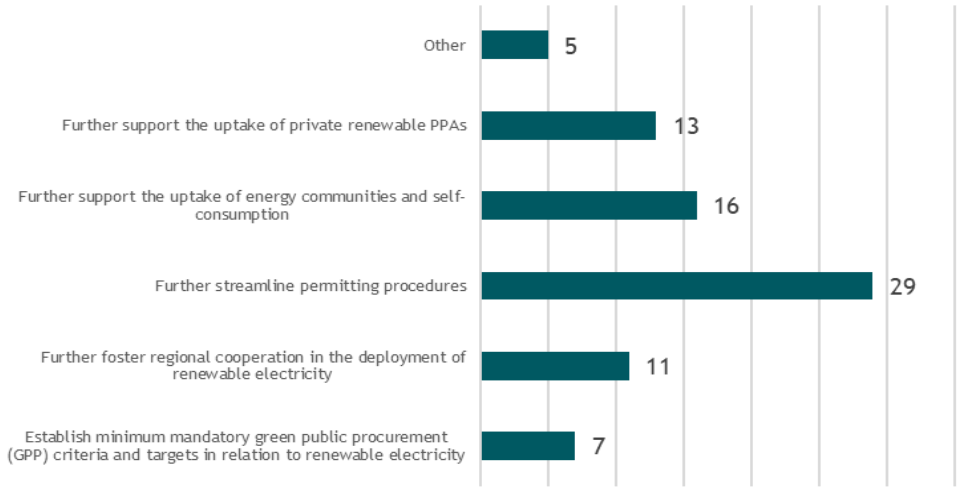



The three most voted additional measures to encourage the use of renewable energy in industry are:

- **Simplified permitting and administrative** (39 votes)
- **Support for corporate sourcing of renewables, including for on-site and near site generation as well as corporate renewable power purchase agreements** (37 votes)
- **Contracts for difference for zero-carbon products and services** (32 votes)

*Session 5 Measures for a further uptake of renewables in electricity*

*Figure 58 - Which of the following measures do you consider the most appropriate in tackling the remaining barriers for the uptake of renewable electricity that matches the expected growth in demand for end-use sectors? (n=81)*

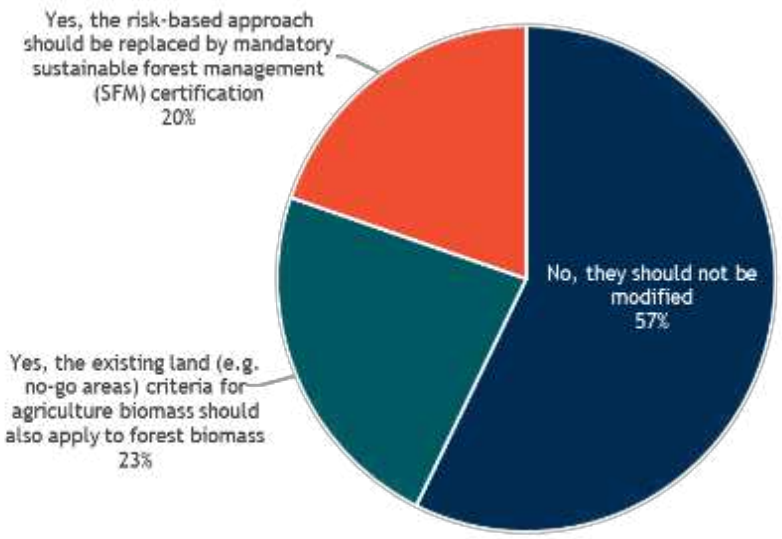


The measures voted as the most appropriate approach to tackle the remaining barriers for the uptake of renewable electricity that matches the expected growth in demand for end-use sectors are:

- **Further streamline permitting procedures** (29 votes)
- **Further support the uptake of energy communities and self-consumption** (16 votes)
- **Further support the uptake of private renewable PPAs** (13 votes)

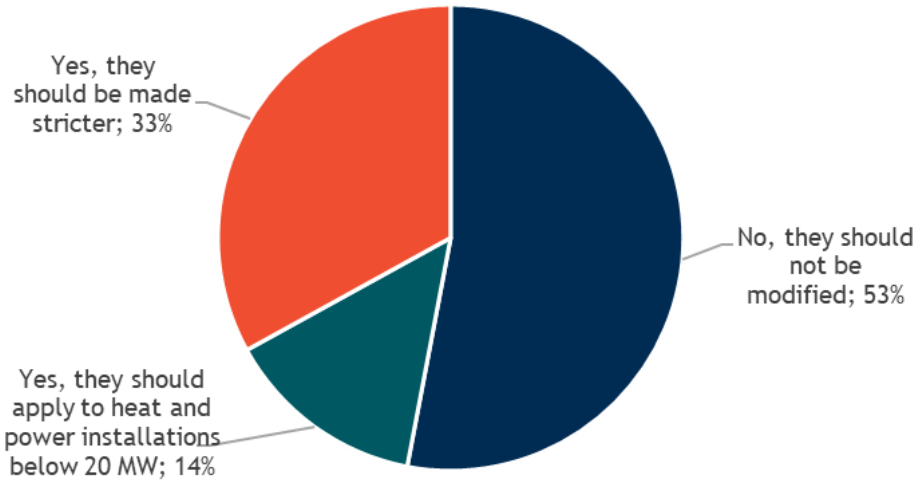
*Session 6 Bioenergy sustainability*

*Figure 59 - Do you think the REDII sustainability criteria for bioenergy should be modified? (n=96)*



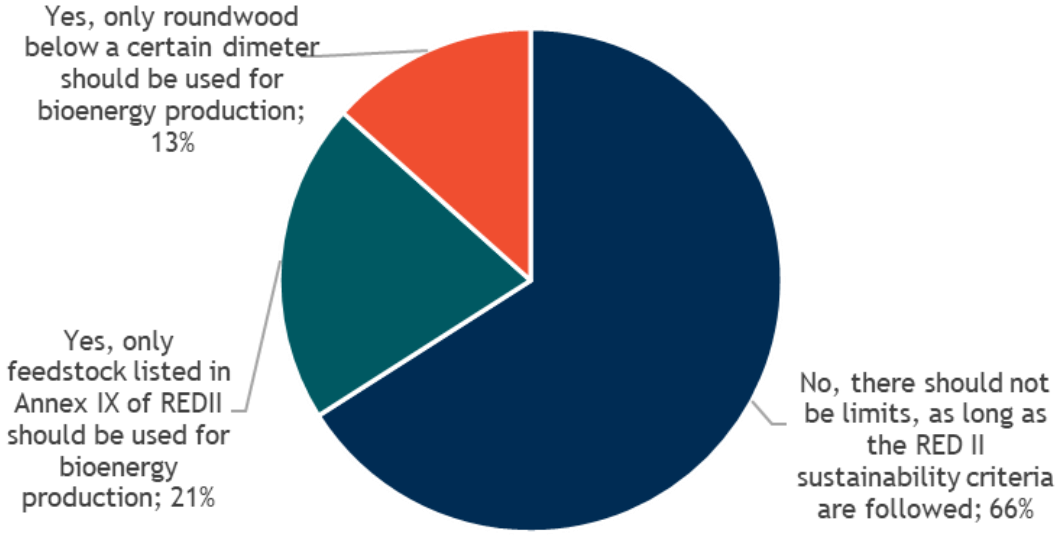

The majority of respondents (54 votes—57% of 96 votes) think that the REDII sustainability criteria for bioenergy **should not be modified**. 22% of the respondents think that they should be modified, and that the existing land criteria for agriculture biomass should also apply to forest biomass. 20 respondents think that they should be modified, and that the risk-based approach should be replaced by mandatory Sustainable Forest Management (SFM) certification.

*Figure 60 - Do you think the REDII sustainability criteria for forest biomass should be modified? (n=100)*



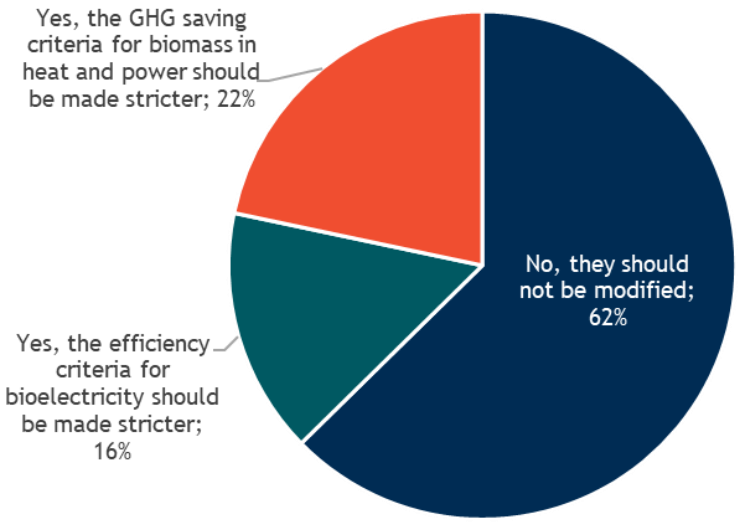

Most respondents (53 votes—53% out of 100 votes) think that the REDII sustainable criteria for forest biomass **should not be modified**. On the contrary, 33 respondents think that they should be made stricter, while 14 respondents think that the criteria should apply to heat and power installations below 20MW.

*Figure 61 - Do you think that the use of certain bioenergy feedstock should be limited under REDII? (n=97)*




The majority of the respondents (64 votes—66% of 97 votes) think that the use of certain bioenergy feedstock **should not be limited, as long as the REDII sustainability criteria are followed**.

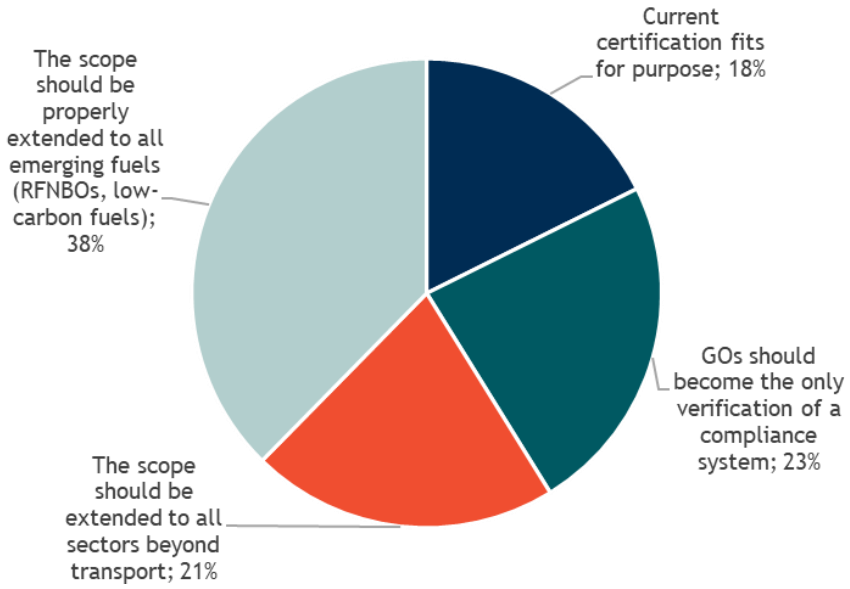
*Figure 62 - Do you think that REDII criteria on GHG emission savings and bioelectricity efficiency should be modified? (n=83)*




Most respondents (52 votes—62% of 83 votes) think that the REDII criteria on GHG emission savings and bioelectricity efficiency **should not be modified**. 38% of the respondents (31 votes) think that the criteria should be made stricter.

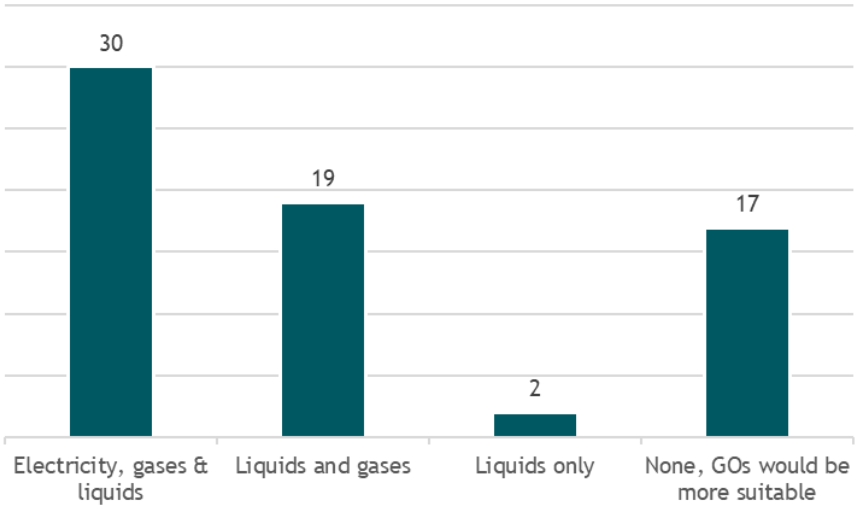
*Session 7 A European system for certification of renewable and low-carbon fuels, including hydrogen*

*Figure 63 - Is the RED II certification scheme appropriate to address sustainability issues, ensuring traceability, and accounting for the different targets (global renewable and sector targets, as in transport under Article 25)? (n=85)*




38% of the respondents (32 votes) think that the REDII certification scheme should **be properly extended to all emerging fuels (RFNBOs, low-carbon fuels)**. 23% of the respondents (20 votes) think that GOs should become the only verification of a compliance system, and 21% (18 votes) think that the scope should be extended to all sectors, beyond transport. 18% of the respondents (15 votes) think that the current certification fits its purpose.

*Figure 64 - For which renewable and low-carbon fuels would the Union Database be the appropriate tool? (n=68)*




44% of the respondents (30 votes) think that the Union Database would be the appropriate tool for electricity, gases, and liquids, followed by liquids and gases (19 votes—28% of 68 votes). A quarter of the respondents (17 votes) think that GOs would be a more suitable tool instead.

*Summary of the sessions*

The workshop was started by the opening address of DG Ditte Juul Jørgensen, DG Energy, European Commission. In her remarks, DG Juul Jørgensen referred to the positive outcome that the European Council achieved in the evening of 10 December 2020, by reaching the agreement on the 2030 climate target of 55%, on the multi-annual financial framework and on the EU Recovery and Resilience Facility.

With an ambitious target set for 2030, and a clear policy objective established, the EU has now set a strong foundation for the ongoing work on the revision of the Renewables Directive, so that it can help the EU achieve its climate goals. The EU has been able to decouple economic growth and GHG emissions, as a result of the efforts across the different levels of society, from local communities to businesses and various organisations. About 20% of energy comes from renewable sources today, and renewable sources deliver one third of EU electricity. This shows that the EU power systems can cope with high levels of variability that comes with a higher share of renewables.

The current RED was adopted in 2018, to be implemented by Member States no later than June 2021, and set a binding target of 32% across the EU. It sets out measures for different sectors, and sets indicative targets in the transport, heating, and cooling sector. Collective commitments are likely to achieve 33.1%-33.7% of renewable share as part of the overall energy consumption in 2030. However, this will not be enough to mitigate climate change, and to reach the increased ambition of at least 55% reduction of GHG by 2030.DG Energy is working with other DGs in the European Commission to implement the Green Deal by reviewing a long list of directives. Shares of renewables in final energy consumption should amount to 38% to 40% in 2030 in order to reach the revised climate targets. Decarbonising the transport sector is a key challenge and there is no single solution. Nonetheless, the Sustainable Mobility Strategy was approved earlier the

week, and the Renewable Energy Directive will provide a strengthened framework. Heating and cooling accounts for 50% of our energy consumption, and three quarters of the energy used comes from carbon sources. An increase of the renewable share in Heating and Cooling would be important to help the EU meet its climate targets. Hydrogen and system integration strategies are also important to help decarbonise the hard-to-abate sectors which are currently carbon intensive. The Renewable Energy Directive is expected to bring positive value to the EU, providing quality green energy jobs, reducing energy imports, reducing costs for household and business consumers, and improving the health and benefits of EU residents.

### *Session 1 The role of renewables in 2030 on the way to a carbon-neutral economy*

*Table 28 - Details of Session 1*

| Time | Moderator | Panel |
|---|---|---|
| 10:15 –11:15 | **Paula Abreu Marques,** Head of Unit for Renewables and CCS Policy, DG Energy, European Commission | • **Dolf Gielen**, *Director,* IRENA Innovation and Technology Centre<br>• **Günter Hörmandinger**, *Deputy Executive Director,* Agora Verkehrswende<br>• **Philipp Offenberg,** *Program Manager,* Europe at Breakthrough Energy<br>• **Simone Mori,** *Head of Europe, Executive Vice President,* Enel |

#### *Position of each panellist*

**Dolf Gielen, Director, IRENA Innovation and Technology Centre**

- The increased ambition level in the GHG reduction target is important and gives a global signal. The existing RES and EE targets are still quite recent. According to IRENA's calculation these targets would yield 45 to 46% emissions reduction. It is an increase now from that level to 55%, which means that there is a revision of targets needed for RES and particularly for EE. The NECPs show the countries ambitions and the aggregated commitment is higher than the EU's RES target. However, on EE there is a shortfall. There is a bit of interaction between RES and the EE target. So, it is important to also work more on EE.
- There has been positive development on renewable power, e.g., around Offshore Wind. But it is also important to work not only on generation but also on the flexibility (enabling grids, smart grids, more demand side flexibility). A mix of technology, marketing & regulation measures, operating practices will be needed.
- Regarding the electrification of end-use sectors: electromobility is moving faster in transport than previously estimated. There is a lot of attention for cars but electrifying commercial vehicles also deserves (more) attention.
- Investments in EE of buildings need to increase. It is important to work on the efficiency so as to not install RES in buildings that are not energy efficient.
- Hydrogen and green commodities in general also need more attention. Need dedicated policies for renewables to put the energy transition on track.

**Günter Hörmandinger, Deputy Executive Director, Agora Verkehrswende**

- Usually, someone interested in transport, only paid attention to the transport-side view of the RED. Recently electrification is coming along more quickly than expected. Instead of looking at transport-specific energy carriers, now we also look at electricity, which is a commodity for the whole economy.
- Before combustion was the "thing", now we see a transition starting to happen.
- If transport becomes a really large consumer of electricity, would it be more useful to focus on electricity as such?

- What will happen to the combustion engine? We get clear signals from the car industry that they cannot pursue two technologies in the future (production lines). Until 2030 the majority of cars on the road will still be combustion engines. In perspective – the newest cars drive the most. The transition in the consumption of the fleet will change faster than the actual fleet will indicate.
- With regard to the increased level of ambition: this is not a pathway to lose economically but the contrary. This is a way to stay at the forefront of the technology development. Will Europe be the buyer? Or the developer of the technology?

**Philip Offenberg, Program Manager, Europe at Breakthrough Energy**

- Breakthrough Energy mission is to speed up the energy transition, focused on energy technology and innovation. 3 main challenges on the road to 2030:
    1. Quick rollout of existing technologies. An important discussion we should have is that land is a limiting factor. We need innovation to create more efficient technologies (both for more generation, but also for less space needed).
    2. Innovation, we need to deploy more innovative technologies quickly. EU has programmes to push innovation, e.g., Horizon framework, Innovation Fund. The RED could create a demand pull for EU major energy technologies. Why don't we propose that a portion of this percentage should be reserved for innovative technologies? Or think of creating a fund that targets innovative technologies.
    3. Global cleantech race – "race to the top" – between China, the new US administration and Europe.

**Simone Mori, Head of Europe, Executive Vice President, Enel**

- We strongly support this new more ambitious target. Because we are convinced that there is a room for investment, for decarbonising, especially with electrical renewables. We have the evidence that there is a way to decarbonise electricity in a very cost-efficient way. What should we do in Europe in order to achieve the target?
- The new target implies more than doubling the number of electrical renewables installed in Europe in the next 10 years. This means increasing the rate of investment in RES by 50% versus the last year. We have the technology, the finance, and the big players, however investments are not delivering at the level that would be expected. There are not enough projects to fulfil the demand in the planned tenders, there is a clear bottleneck in the tender procedure. Current Article 16 of RED is not enough. It is important to increase the enforcement of the Governance, we need more coherence, a more top-down European model. We understand that there is a problem of battle of power (EU, MS, local decisions). But this is clearly the number 1 constraint to achieve a fast and cost-effective decarbonisation.
- We need to reinforce harmonisation and integration of the European Market. We support the creation of Pan-European or macro-regional tenders. Putting together the different markets to create a real Pan-European market ground would be very important to improve the investibility of the sector.
- The market: The European power market is based on the rules that were created 20 years ago, and in a market that was completely different: a short-term market based on the marginal costs of plants. Now, according to the new targets there will be the majority of power generation based on zero marginal cost production. We need a new thinking injected in this segment, to update the market to these new technologies.
- It is also important to bring decarbonised cheap electricity to the customers and sectors which are not utilising it today, especially in the transport sector. To

create a mechanism to quickly decarbonise the sector/kickstart the market in the earlier years.

- To be avoided: fragmentation of the support schemes. This prevents the market to work properly.

### *Session 2 Renewable energy in Heating and Cooling, Buildings and District Heating*

*Table 29 - Details of Session 2*

| Time | Moderator | Panel |
|---|---|---|
| 11:15 –12:15 | **Eva Hoos,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Brian Vad Mathiesen**, *Coordinator of Heat Roadmap Europe*, Aalborg University<br>• **Andrej Jentsch**, *Operating Agent,* IEA Technology Collaboration Programme on District Heating and Cooling, including Combined Heat and Power<br>• **Patrik Pizinger,** *Mayor*, City of Chodov, Czech Republic<br>• **JP Prendergast,** *Chairman,* Claremorris and Western District Energy Co-Operative<br>• **Philippe Dumas**, *Secretary General,* EGEC |

#### *Position of each panellists*

**Brian Vad Mathiesen, Coordinator of Heat Roadmap Europe, Aalborg University**

- EE costs (?)may become very high for building; we may need to decarbonise another way. Target at a more system-wide level (not suitable at building level), RES is part of the energy system. Such(building-specific) target could become very expensive (and miss the level of heat needed);
- Have an integrated planning measure (EU/national/local). Buildings that have a neighbour can sometimes work together (otherwise individual HP), then DHC. EU/national planning procedure enabling local municipalities to deploy the required infra. The local level is key, understand the main problems (factors), and gather initiatives. Allow using waste heat (including "black energy" -> waste energy from fossil fuels), and other RES (like geothermal, solar thermal, bio);
- DHS as infrastructure, not as final energy demand, … offers many evolving opportunities;
- Energy system integration, HP helps electrification, but it would not be efficient through individual systems. It would be more efficient to decarbonise at DHC level than at individual. Allow also to store energy (heat).

**Dr Andrej Jentsch, Operating Agent, IEA Technology Collaboration Programme on DHC, including CHP**

- Important to have the right metric: carbon neutrality (rather than renewability) now (rather than in the future, analogy of a cut tree). Need to revise the methodology to determine the emission, to make it accurate with the most recent scientific findings. Take scientific knowledge, to define the goal;
- Increasing of RES is possible, large deployment of DHC
- Good playing field for economic and regulatory deployment of DHC

**Patrik Pizinger, Mayor, City of Chodov, Czech Republic**

- Strong role for DHC, for Chodov the main driver was to phase out from coal (DHC exists since '70). DHC only option in such city, with many (3,000) flats;
- Local authority's role is to deploy and make it more efficient (no other choice than DHC);

- DHC should be an attractive choice for users (alternative is natural gas). But Chodov wanted to take green choices; Need to find the right source of heat.
- National and EU levels need to be involved, should support to increase the efficiency of existing infrastructure (currently 20% in losses);
- Increasing carbon footprint (incl. EE) of existing infrastructure is a no-regret option
- Secure DHC needs support, EU, national and local. EU should provide support to local authorities with advice for taking right technology choices and financially for infrastructure upgrade

**JP Prendergast, Chairman, Claremorris and Western District Energy Co-Operative**

- Answer from the perspective of a community (aim at 100% RES), number increases exponentially
- Community allows empower other communities, key players have an important role, especially as it pertains to implementing policies (rural and urban);
- Waste-heat use in cities, Bioeconomy, zero-waste economy, especially relevant for the rural communities. Integrated with local resources extracting value, community focus generating energy for DHC;
- Planning, acceptance … streamlined fashion. Not effective at the moment, should change the communication. Lack of training. We need an enabling framework. Joined approach to decarbonise H&C
- Communication from top to down, and bottom to up, both channels are essential. Need for a common message across Europe, common approach to communication;
- Need legal framework to enable prosumers;
- Combination of technologies, DHC is the infra to facilitate this combination. Lead by example;
- This is also about job creation;
- Important to involve communities, not only the fairest but the fastest way.

**Philippe Dumas, Secretary General, EGEC**

- Art 23 is not enough. Electricity with a market design has been successful. We need heat market design, heat market policy, with fair competition (for all RES). Technologies are competitive and mature, but the frame is not fair. We do not allow DHC installation;
- TEN-E should ensure DHC becomes eligible (TEN-H), allow cross-border, but not local infra, is not fair;
- We need the internalization of external (system) costs;
- We need to exchange best practices, planning, heat forum, ENTSO-H to plan infra, cities are key actors, urban planning, … a proper institution at EU level;
- Art. 23 is a good first step, but we can do better.

*Q&A*

- Gas is many things (several types), should be used as backup for power and heat, "Fit" gases are biogases (from agriculture, biowaste and gasified biomass);
- Avoid use hydrogen in building, increasing the cost;
- HP key for sector integration, but answer remains individual in each MS. No EU legislation to impose, but we need a push to ensure MS assess opportunities for DHC;
- Roadmap where we need up to 25 000 grid DHC connections. At least 18000 new grids by 2030. Also, problem with refurbishing existing grids;
- Need for a broader understanding of the value of biomethane value chain.

*Coverage of topics in Session 2*

- Role of local authorities;

- Integrated planning;
- Good communication channels (all directions);
- Enable local communities, and use technologies;
- Increase ambition, actions should be facilitating;
- Renewable fuels, clear on their value chain, to make the best use.

### *Session 3 Renewable energy in transport*

*Table 30 - Details of Session 3*

| Time | Moderator | Panel |
|---|---|---|
| 12:15 – 13:15 | **Bernd Kuepker,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Paul Durrant,** Head of End-use Sectors & Bioenergy, IRENA<br>• **Geert Decock,** *Manager, Electricity and Energy*, Transport & Environment<br>• **Gloria Gaupmann**, *Chair of the Advanced Biofuels Coalition, & Head of Public Affairs, Technology & Innovation,* Clariant<br>• **Simon Bergulf,** *Director of regulatory affairs,* Maersk<br>• **Maarten Van Haute,** *Alternative Fuels Officer,* Q8 |

#### *General Introduction (Bernd Kuepker, DG ENER)*

This panel session focuses on the possibilities and challenges of a high integration of renewable energy in the transport sector.

Progress is required for the transport sector: Following the EC's impact assessment of the CTP, a significant increase in the targeted Renewable Energy Share in Transport (RES-T) from currently 14% by 2030 as laid out in RED II to about 24% by 2030 may be required to meet the 2050 GHG emission target. In addition, the EC's 'Sustainable and Smart Mobility Strategy' published on 9th December 2020 outlines the upcoming challenge. The EC is also re-evaluating the AFID, $CO_2$ standards for cars, FQD, ETS and new initiatives to promote the uptake of renewable fuels in the aviation and maritime sectors.

The aim of this particular workshop is to discuss how to improve specific policies and measures in RED II necessary to meet ambitious 2030 targets without a complete policy change. It should cover the level of ambition, new measures as well as a stable investment framework.

#### *The position of each panellist*

**Paul Durrant, Head of End-use Sectors & Bioenergy, IRENA**

- In transport, there is a need for a similar tipping point as has been seen in renewable electricity production. A focus on solutions that are consistent with reaching net zero is necessary, do not waste resources on solutions that will not contribute to this end goal..
- One issue is that the ultimate mix in transport is still unclear. In the short term, focus should lie on electrification, as it has become clear that it will be the dominant option for transport (cars, LDV, somewhat unclear still for HDVs).
- Whereas hydrogen will have a significant role in 2050 timeframe, it's contribution until 2030 will be very limited. Short term focus regarding hydrogen needs to be on establishing the enabling conditions , including infrastructure, GOs, standards & certification, and investments in electrolyser to further reduce costs.
- Aviation and shipping cannot be ignored. While only limited progress is expected in this decade it is, however, necessary to lay the groundwork for the 30s and 40s (with net zero goal in mind).
- The role of biomass seems very underestimated in the current debate, since it will be necessary for a significant share of the global energy supply (around 20-

30%) according to IRENA calculations, for achieving the decarbonization goal. It is of crucial importance to make use of sustainable biomass.
- Electrification seems somewhat underrepresented in RED II as it has become clear that electrification will be dominant.

**Geert Decock, Electricity and Energy Manager, Transport & Environment**

- To reach the -55% GHG reduction target a significant change is required, following the EC's Sustainable and Smart mobility Strategy: "Overall we must shift the existing paradigm of incremental change to fundamental transformation." (SWD(2020) 331 final). The importance and role of different elements in RED II are outlined in the following five aspects:
- 1) In general, T&E advocates "quality over quantity". Better a lower target of sustainable fuels than higher targets fulfilled with unsustainable fuels. In line with this, besides targets for different fuels T&E is rather in favour of a GHG-driven approach, where best performing fuels are rewarded.
- 2) Electrification: The new provisions should move beyond a mandate (as implemented for biofuels). Also need to integrate aviation and shipping sector. Efforts need to be coordinated across transport sectors. Create synergies instead of hurdles. Support should rather focus on a credit mechanism, as implemented, e.g. in NL or FR.
- 3) Biofuels: A phase out of high-ILUC fuels such as fuels from palm or soy oil should happen soon. Other crop-based biofuels should be phased out over time. It is important to eliminate "loopholes", like the low-ILUC category.
- 4) RED II moved away from biofuels to more advanced biofuels. Next revision needs to mover further. Advanced biofuels are limited and will not be able to contribute significantly towards the energy supply in 2050 (can only cover 11.4% of expected energy demand of aviation alone). Important to keep competing uses between sectors in mind. Strong sustainability criteria are required (e.g. only waste-based).
- 5) The role of RFNBOs should focus on long-distance transport, notably aviation and shipping. Details will be developed in ReFuel and FuelEU initiatives, which is why no specific targets should be implemented in RED II.

**Gloria Gaupmann, Chair of the Advanced Biofuels Coalition, & Head of Public Affairs, Sustainability Transformation, Clariant**

- The advanced biofuel coalition represents 11 companies from the biofuel sector. The coalition welcomes the Green Deal, but acknowledges the big challenge it poses.
- Biofuels will play a significant role, since by 2030 still 90% of existing vehicles will have an ICE. For a significant emission reduction, both climate neutral fuels as well as strict car emission standards are required. A coherent policy framework is required that stimulates the use of climate–neutral alternative fuels and that also adopts a well-to-use approach on emission standards.
- Production capacities for advanced biofuels are being ramped up. Still, another revision of RED II, which is still in the progress of national transposition, will significantly prevent necessary investments and poison the investment environment.
- Therefore, a revision of RED II should only include minimal revisions for the transport sector, including e.g. increased targets. However, no fundamental changes in rules as e.g. the sustainability criteria, or eligible feedstocks should be performed. GHG reductions should rather be driven by FQD and a technology neutral well-to-wheel approach in CO2 emission standards should be adopted.
- "We would like to see the Commission to only propose a minimally invasive revision of RED II. For the transport sector, make it very clear to the external world and the investors, that the targets of RED II will be increased, that there will be no back-tracking, and, very importantly, don't change the fundamental

rules of the game, such as sustainability criteria or certain feedstock lists of the annexes."

**Simon Bergulf, Director of Regulatory Affairs, Maersk**

- Shipping faces its third revolution. Maritime transport will not only sail on a single fuel in the future. As their assets are 25-30 years in lifespan and targets need to be achieved by 2050, the commercially viable vessels to do so need to be ready at the end of this decade. There is a very strong sense of urgency.
- Laying the groundwork to accommodate different fuels is absolutely key. Strong regulatory framework, certification, rewarding first movers are absolutely key to remain competitive.
- Revision of RED II not needed, rather of Fuel Quality Directive. Although the current role of the maritime sector in RED II and accordingly its progress in decarbonisation so far is rather limited, an upcoming revision of RED II could have significant impact on the maritime sector. An example is the topic of bunkering, since shipping from Europe to Asia mainly only includes 1 bunkering. Therefore, a strong and renewable shipping hub in Europe would be a significant global hub. It is expected that a transformation to new fuels will be connected to significant costs, which is also why there will be no immediate jump to green fuels. Each application within the maritime sector may use an individual fuel in the future.
- Certification, e.g. for used cooking oil and other fuels, as well as tradeable credit systems are important aspects. For the latter, the existing system in the Netherlands should be considered for other countries. With the right framework in other countries, they would invest. The maritime industry sees an urgent need for action and clear regulations – now - due to the long investment cycles and life spans within the industry.

**Maarten Van Haute, Alternative Fuels Officer, Q8**

- Fuel suppliers are transforming to mobility suppliers with different kinds of fuels being supplied to different sectors. Therefore, all kinds of renewable and sustainable fuels should be covered in RED II.
- For suppliers, the fragmented national legislation is difficult and a stronger harmonization within Europe would be supported. Lack of harmonization makes it difficult for a European Player to supply across Europe and comply with different rules.
- Additionally, the alignment of FQD and RED II is important. Sub-mandates would not be useful.
- Vehicle GHG emission standards should be sued to foster electrification rather than RED II.

*A summary of the panel discussion*

- The discussion covered three aspects: i) EU harmonisation of provisions, ii) multipliers, iii) promotion of RFNBOs in RED II
- Regarding harmonisation, a stronger alignment is supported by the panellists, although country-specific potentials and progress should be recognized in different national renewable targets for the transport sector. It is important to keep a holistic view considering other revisions happening and context-specific regulation. It is important not to undermine existing targets and mechanisms by additional measures. T&E would not want the same target for RES-T across MS, but it should be made sure that renewable electricity can be counted towards the transport target in all MS.
- Regarding multipliers, especially the factor of four for renewable electricity in road (Art.27(1)) is seen ambiguously. For some, it is unclear how they are being justified. T&E supports it in absence of a better system (although it is a generous mechanism), since the contribution of renewable electricity in transport will be

limited until 2030. Removing the multiplier would penalize energy efficiency. In contrast to that, biofuel industry sees the risk of an inflation of multipliers. For the maritime and aviation sector existing multipliers should be increased, since the model has worked for electricity in road transport, while the progress in increasing the RES share in maritime and aviation has been limited. In general, however, for fuel suppliers the rationale behind multipliers is already difficult to understand (which also is mirrored in several questions and comments by the audience).

- The panellists agree that RFNBOs – and especially hydrogen for e.g. heavy duty road transport – will play an important role. Still, the impact within this decade will be limited, some argue. Today it is important to build a regulatory framework with sustainability criteria to direct investments into technologies contributing to the strong decarbonisation targets ("move from reduction mindset to transition mindset"). Whether an overall sub-target for RFNBOs would be a suitable measure is seen critical by some panellists, since sector-specific sub-targets (e.g. 1-2% RFNBOs in aviation, or shipping, with ramp up after 2030) will already create demand. This is crucial to bring innovative technologies to the market – in the optimal way.

*Q&A*

Areas and topics raised in Q&A tool:

**Multipliers**
- Focus on reducing $CO_2$ instead of mechanism to drive numbers (i.e. multipliers): multipliers do not multiply the climate impact, but only drive up figures
- Danger of fraud (e.g. multipliers for biofuels in the NL)
- With clear cap for conv. biofuels, no need for multipliers

**Biofuels in general**
- Development of EU Database (with regard to biomass)
- Importance to reduce carbon intensity of current gaseous and liquid fuels for current vehicle fleet, necessity and role of biofuels (also crop-based)
- Advanced biofuels: possibilities beside waste-based biofuels
- Solutions for long haul trucking
- Will the revision of the REDII terminate this artificial and unfit limitation to the use of sustainable waste? (existing RED II 1.7% limitation for contribution of feedstocks in part B Annex IX)

**Crop-based biofuels**
- Potential of biofuels with significant GHG savings, e.g. European renewable ethanol
- EU globally alone in restricting crop-based biofuels
- No neg. impact of crop-based biofuels on food prices and availability (Renewable Energy Progress report of the European Commission (Com2020/952) page 18)
- What is the justification for opposition against crop-based biofuels?

**RFNBOs**
- Delegated acts seem to incentive direct connection between RES and electrolyser → contradicting Energy System Integration
- Rapid ramp up of RFNBOs is essential and would provide benefits now, still legislative framework is missing
- Additionality requirement increases RFNBO costs

**Regulation**
- Set absolute cap for fossil-based fuels (declining until 2050) instead of RES-T shares
- RED II is basis for investment decisions, targets could also be increased in original timeline for RED II
- Only need for higher ambition for RED II targets, but no significant changes (investment)
- Revision before transposition period has ended is not ideal
- RES-T of Art 25 with 14% minimum share only contributes for a very small part to the art. 7 target, it's rather to incentivise specific fuels. Additionality criteria is therefore counterproductive

**Harmonisation**
- Quality/Blending limits in FQD limit higher RES-T → alignment of RED II and FQD
- Move to well-to-wheel approach
- Consider parallel policy initiatives (FQD, CO2 restrictions for vehicles)

**Other**
- Sustainable and Smart Mobility Strategy : details on upcoming Renewable and Low-Carbon Fuels Value Chain Alliance?
- How to achieve 25% in CTP with only 30 Mio. EVs and increasing energy consumption

## *Session 4 Renewables in industry*

*Table 31 - Details of Session 4*

| Time | Moderator | Panel |
|---|---|---|
| 14:30 – 15:15 | **Ruud Kempener,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Martin Porter**, *Executive Chair,* CISL Brussels<br>• **Peter Botschek,** *Director of Climate Change and Energy,* CEFIC<br>• **Aurelie Beauvais,** *Deputy CEO and Policy Director,* SolarPower Europe<br>• **Mikael Nordlander,** *Head of R&D portfolio Industry Decarbonisation,* Vattenfall AB |

### *Position of each panellist*

**Martin Porter, Executive Chair, CISL Brussels**

- Role of increased use of RES through 3 sections: competitiveness, RES industry, industry broadly;
- Competitiveness : more difficult than thought, in the context of sustainable development in general, paradigm shift... how to measure comp.? An Innovation-centric approach is key. Domestic and Global market opportunities, EU has advantages on the world scene. Will we be buying or selling the technologies? Need to look at opportunities the industry has regarding value chains, the industrial ecosystem etc.
- European Roundtable of Industry encompasses the following: manufacturing, energy industry, renewable will benefit, macro-economic benefits, jobs, but not uniform, some leading, others not. Make the right decision on policy and regulatory to allow their deployment;
- Industry more broadly (cement, steel, chemical, ), competitive advantages if cost reduction, with electrification as a key element. How to incentivise our ability to invest in electrification? Look at other aspects (side-by-side RES) such as circular economy, material use, demand side is important.

**Peter Botschek, Director of Climate Change and Energy, CEFIC**

- Chemical EU: biggest energy consumer, 2/3 is gas & electricity consumption (already now), biggest global exporter, energy cost is very important;
- GHG reduced more than 50%, to 1990, but still to be expected;
- RES will play important role to help decarbonise;
- Developed different pathways, circularity, hydrogen, renewables, recycling, closing the loop are important aspects to look at;
- To decarbonise, electrification is essential, but it requires more RES electricity (even if process electrification leads to EE). Regarding renewable energy, the chemical industry in Europe predicts 140% more energy use than the IEA predicts to be available by 2050 (in capacity);
- Access to affordable, reliable low-carbon energy is essential. Access RES renewable, with competition / innovation as main force, and not normative or obligation;
- Electrification will results in efficiency loss in the end-use process. Something to be considered under the EED.

**Aurelie Beauvais, Deputy CEO and Policy Director, SolarPower Europe**

- Important to increase RES, industrial demand is a huge market, growing exponentially in EU (RE100 forecasted more than 6GW PPA in 2020 → PPAs

grew by 100% in 2020 compared to 2019, corresponds to 20% installed capacity from solar & wind in 2019). Other segments, (e.g., commercial and industrial rooftops) potential would reach 140GW by 2030; (compared to H2 strategy – 120 GW);
- More and more driven by the market, less and less support needed from public money, makes the green deal more achievable, reduce the burden on public and citizens;
- PV & wind are the most competitive : potential is huge (good for the need of industry), cost competitive everywhere (not only in south and/or north → the more cost competitive the more available it can become everywhere), becomes enabler of the Green Deal and decarbonisation of industry;
- Competitiveness and innovation : RES makes business sense, next is to scale up. Innovation remains important, RES and electrification moving frontier (and other technologies., e.g., H2);
- Big potential for RES H2, ready to harness the challenges. Accelerate the maturity and cost competitiveness.

**Mikael Nordlander, Vattenfall R&D Portfolio Manager Industry Decarbonisation**

- Hybrit is a disruptive solution, it cannot be done without cooperating, it is important;
- Working in value-chain;
- Harvest RES through electrification is essential;
- Majority capex in RES, at Vattenfall;
- Barriers: cost could be considered (but weight in final product remains limited, as it impacts an intermediate material, cheap. Cost increase to end consumer is low);
- Firm belief this green characteristic will have a value for the final consumer;
- If early mover (e.g., SSAB, LKAB), de-risking is important;
- Additionality, if high demand in industry, but it depends (e.g., wind Elec deploys rapidly in Sweden). So, no need to focus on additionality.

*Q&A*

- How important is demand for green products, has EU advantage > large well fit domestic market, demand is created by standards, also the materials (with replication outside EU)
- Not yet a key driver, efforts made by some MS to buy, e.g., electric vehicle, with limited results. The profit margin for a car is surprisingly low, … it could become challenging. Elasticity of consumer are different;
- Chains are all different. Leaning the believe in the market is not enough. Need for policy, support (CfD?);
- How RES could be provided to SME, can be entirely be decarbonised through electrification (PPAs, ….). Remove barrier: target increase (extra boost to the market); administrative barriers (regulatory); low hanging fruit (appropriate framework, like imposing tendering for small installations is not appropriate). Supply side, green (broadly than carbon) is a competitive advantage, for branding. But more often cost is key… should decrease and increase competitiveness.

*Coverage of topics in Session 4*

- PPA
- Innovation & research, scaling, business modelling
- Administrative barriers (permit)
- CfD (technology neutral, dilute the funds), review state aid guidelines, link with PPA
- GOs, traceability is key

- De-risk instruments

*Session 5 Measures for a further uptake of renewables in electricity*

*Table 32 - Details of Session 5*

| Time | Moderator | Panel |
|---|---|---|
| 15:15-16:00 | **Antonio Lopez-Nicolas** (Deputy Head of the Renewable Energy Unit, DG ENER) | • **Dirk Vansintjan**, President of the European federation of citizen energy cooperatives, RESCOOP<br>• **Giles Dickson**, CEO, Wind Europe<br>• **Bruno De Wachter**, Convenor of the Working Group Market Design and RES, ENTSO-E<br>• **Hélène Lavray**, Senior Advisor - Renewables & Environment, Energy Policy, Climate & Sustainability, Eurelectric |

*Introductory statement by Antonio Lopez-Nicolas*

The first sessions focussed on end-use sectors, in line with the CTP IA. Yet it does not make the power sector less important. RES-E share should increase from 32% to 65% by 2030 (most of it being variable renewables). On the demand side, it would happen with an electrification of end-use sectors, and indirect electrification of hard-to-abate sectors. Barriers remain though: renewables have a 1.5% annual installation rate increase only, which needs to double during the next decade. How to make the increase happen?

*Position of each panellist*

What major **barriers** do you see in the deployment of renewables in the electricity sector by 2030, in order to build an integrated energy system with at least 65% of renewable electricity share?

**Bruno De Wachter, Convenor of the Working Group Market Design and RES, ENTSO-E**

- Two issues: need to install renewables, and to operate them in real time
- The electricity networks have to follow as well, along all voltage levels. **Permitting is a major problem for transmission grid as well.** Only 10 years for this exercise, while it takes 10 years for permitting and 3 years for construction.
- Need to go further and further offshore, including **offshore grids**. There is a need for a **stable regulatory framework** (in particular for hybrid assets).
- RES: national support mechanism: will it be the most appropriate way to support RES deployment in the future? Today, we do not value enough renewable electricity. And the Guaranties of Origin system means nothing on RES-consumption (lack of temporal and spatial consistency). Need to come up with **another system, more transparent: more in real time**. Start with a voluntary system (industries) and then something compulsory. It would incentivise demand to follow production.

**Dirk Vansintjan, President of the European federation of citizen energy cooperatives, RESCOOP**

- So far high voltage consumers are **exempted from contribution to RES support costs**, as well as conventional power generators. Generates a lack of trust from citizens.
- Happy with REDII on energy communities; but MS should set a **sub-target** for energy communities, **tax shift** from green to grey energy carriers; provide **access**

**for energy communities to district heating** (less monopoly from DSOs, more empowerment for companies and businesses).

**Hélène Lavray, Senior Advisor - Renewables & Environment, Energy Policy, Climate & Sustainability, Eurelectric**

- Investment cycles are rather long, there is a need for a **consistent 2030 framework as quickly as possible** (ETS, Energy Efficiency Directive, other instruments such as the TEN-E regulation).
- **Permitting: a pressing issue** - permitting issue for wind and solar but also hydro and distribution system. REDII goes in the right direction, but more could be done e.g., speed up for PCIs, DSOs too.
- Disappointed by the **electrification rate in CTP's IA**. E.g., in the road transport sector and for indirect electrification. Classification of e-fuels should be clarified.

**Giles Dickson, CEO, Wind Europe**

- **Permitting: rules too complex, processes too slow.** Not enough civil servants on the processes. It acts as a bottleneck. Today 12 GW/y of new wind capacity; for 2030 need to rise to 21 GW/y (under the 32% RE target), or to 26-28 GW/y of new wind capacities (under the 40% RE target). Issue: they cannot afford permitting delays. Commission is to enforce Articles 16 and 17, yet it will not be enough to deliver the new increase. **Need to proactively drive the simplifications**. **Not reopening the article but adding to it a system of benchmark** – for instance based on the KPIs determined by the project RES Simplify in January, as an Annex of the Directive.
- **Guarantees of Origin**. The demand side is crucial. Art 19 is not delivering that, there is a need for traceability of each unit of renewable electricity: **GOs should be made mandatory**. Do not introduce in the RED measures that would concern low carbon energies, as the directive should focus exclusively on renewable energies.
- **Need to keep financing cost very low**, as today it can represent the largest share of total costs. **Contracts for difference** are very good to de-risk investment. They are good for governments too, as the industry pays back when market prices are high. **It is crucial to have this revenue stabilisation mechanism.**

### *Session 6 Bioenergy sustainability*

*Table 33 - Details for Session 6*

| Time | Moderator | Panel |
|---|---|---|
| 16:00-16:45 | **Giulio Volpi,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Uwe Fritsche,** *Task Leader of IEA Bioenergy Task: Deployment of biobased value chains,* IINAS<br>• **Robert Matthews,** *Programme Group Manager,* Forest Research<br>• **Linde Zuidema,** *Forest and Climate Campaigner,* Fern<br>• **Jean-Marc Jossart**, *Secretary General,* Bioenergy Europe<br>• **Lotta Heikkonen**, *Forest Policy Advisor,* Confederation of European Forest Owners |

*Position of each panellist*

Q1: What is the role of bioenergy up to 2030 and towards the 2050 target?

Q2: Is the current set of criteria (such as sustainability criteria, minimum plant size, LULUCF accounting) sufficient to ensure biomass for energy is harvested and used sustainably and is effectively reducing GHG emissions?

**Uwe Fritsche, Task Leader of IEA Bioenergy Task: Deployment of biobased value chains, IINAS**

- Up to 2050 and beyond, bioenergy is still necessary in all scenarios on a global scale; it will be also very relevant for developing countries. The question is thus what kind of bioenergy we will use rather than if it will be used at all;
- In the context of bioeconomy's sustainability, it is important to consider interactions with fossil, mineral, renewable systems as well as bioeconomic contributions to ecosystem services are important, considering dynamic interlinkages and substitution effects. The bioeconomy is the only system providing food, feed, and eco-system services, for which there is no substitute.
- In a sustainable bioeconomy, we should focus on the use of bioenergy in sectors that are hard to decarbonise (aviation, shipping, hi-temperature industrial heat). The question is – which feedstock?
- Even bioenergy production could enrich biodiversity, net-positive approaches exist already but need to be scaled up.
- Bioeconomy can provide further income for rural areas that face economic decline due to urbanisation. There are now small-scale bio-refineries, which produce fuel and could be a long-term sustainable solution.
- Bioenergy should not increase competition for land. This means keep looking for waste reduction, restoring land, and intercropping.
- RED II was important in driving a change towards a bioeconomy. A revision of RED could improve the governance of these processes and speed up their uptake.

**Robert Matthews, Programme Group Manager, Forest Research**

- The premise that bioenergy delivers zero emissions when used is true only sometimes.
- Timing of emissions is an important aspect: initially the GHG emissions of certain bioenergy are high, only in long-time perspective when the crops or trees regrow the balance is restored.
- There is now more scientific understanding to distinguish impact of particular fuels and can be used for differentiated approach, for example for bioenergy sources. These have to be considered when designing new policies.
- These aspects have to be considered when designing policies towards 2030 and 2050.

**Linde Zuidema, Forest and Climate Campaigner, Fern**

- Towards 2050, EU will have to reduce emissions and remove CO2 from the atmosphere to reach its carbon objectives. Land and forest are the best options to remove CO2, but this depends on how sustainably they are managed.
- Currently, the sustainable management of forests is not done properly, harvesting for biomass fuels and other short-term uses is occurring. Woody biomass is currently 35% of renewable use mix.
- The use of biomass has negative impacts in the short timeframe where the climate action has to be taken; it has also negative impacts caused by other GHG emissions, air pollution and biodiversity. The investment in biomass is diverting investment in other cleaner technologies.
- The risk-based approach is flawed: RED does not address risk of increased forest harvesting, e.g., using whole harvested wood for fuel of wood with high carbon content.
- Also, LULUCF not accounting for all uses, some emissions are left unaccounted
- EU rules currently do not encourage sustainable use and incentivise short term biomass use over carbon sinks.

- A weak risk-based approach cannot balance a plethora of incentives and funds destined to support forests harvesting. Data shows that biomass burning has negative effects, but MSs are not transparent about the impacts. Without additional restrictions on feedstocks, a phase-out plan for use in heating and power, and a reduction in regulatory and financial incentives, wood biomass should not be supported by RED.

**Jean-Marc Jossart, Secretary General, Bioenergy Europe**

- On the market: MS national plans are focussed on renewable resources at national level, and they expect an increase in bioenergy use of 49% in bioenergy by 2030. Afterward it is unclear.
- MS tells us that there is a huge potential, forests grow, and we harvest lass than the amount gained by the growth in forest mass: we harvest less than 2/3 but forests grew by 47% in the last 30 years. This use is sustainable, so it will be there in 2050.
- Market: wind and PV will play a growing role, but bioenergy has added value as a flexibility source. Because of bioenergy, the EU will need to invest less in grid management and storage.
- Heating: modelling suggests a reduced use of biomass for heating, but this is not certain. This is because biomass is an affordable source, both for distributed and district heating, also for high-temperature industry applications (e.g., steam). Due to low prices, it is a solution also for fuel poverty.
- Bioenergy a key pillar in any 2050 strategy.
- Sustainability criteria**:** It should be recognised that bioenergy sector has already substantial sustainability regulation. Bioenergy is the only sector with strong sustainability requirements, such as reducing emissions in the supply chain (70% required); no other sector covers supply chain and emission in third countries.
- Bioeconomy industry is looking at the EU, and continuing changes will discourage investment. For bioenergy, the EU should not repeat the same mistakes made for biofuels by providing an approach too complex and that changes too often.

**Lotta Heikkonen, Forest Policy Advisor, Confederation of European Forest Owners**

- 16 million forest owners
- EU forests are essential for decarbonising the energy system.
- Guiding principles are Sequestration, storage, substitution – and bioenergy plays a fundamental role
- Commission analysis shows need for increased bioenergy consumption, in hard-to-decarbonise sectors and provide flexibility for the electricity grid.
- Are current criteria sufficient? They have not yet been implemented (this will start next summer), so it is not possible to evaluate their effectiveness yet;
- Reopening the sustainability criteria before it has been implemented, it will be a burden on forest owners. The instability of regulatory system is harmful to forest owners (e.g., increasing administrative burdens) and it will not give the good signal to forest owners.
- Risk-based approach already delivers sustainability benefits, and sustainable forest management fully accounts for main sustainability principles. The focus of forest owners is to maintain a healthy forest ecosystem, and this is achieved by the current approach to sustainable management.
- There is already national-level legislation that works
- Finally, we do not need to reinvent the wheel. There is a need to support forest owners to adapt their approach to new conditions and requirements.

## *Session 7 A European system for certification of renewable and low-carbon fuels, including hydrogen*

*Table 34 - Details of Session 7*

| Time | Moderator | Panel |
|---|---|---|
| 16:45-17:30 | **Galin Gentchev,** *Policy officer, Renewables and CCS policy,* DG Energy, European Commission | • **Jorgo Chatzimarkakis**, *Secretary General,* Hydrogen Europe<br>• **Peter Styles,** *Executive Vice Chair,* EFET Board<br>• **Sascha Wüstenhöfer**, *System Manager,* ISCC International Sustainability and Carbon Certification<br>• **Javier Castro,** *Business Development Carbon Management Service,* TÜV SÜD Industrie Service<br>• **Sacha Alberici,** *Managing Consultant,* Guidehouse |

*Introduction from moderator – main issues addressed*

- How to integrate, streamline and widen to other sectors the certification system in order to have a fully-fledged certification system where all works in a complementary way
- The traceability across the value chain needs to be ensured; this is different for various types of fuels
- It is also a question of technical implementation, with the existing system(s), avoiding also double counting

*Position of each panellist*

**Jorgo Chatzimarkakis, Secretary General, Hydrogen Europe**

- Carbon content of fuels is the new currency/metric (to set a price). GO, certification schemes will be needed in the future H2 markets (in future, hydrogen will be carrier but also a feedstock).
- It is not possible to just copy other gas regulations. For gases, there are many certification schemes, not all trustable. Another suggestion might be the electricity certification schemes, but they require physical infrastructure (to book and claim).
- Ask for a new hydrogen certification scheme è 5T principles for certification scheme: traceability (source/origin), trackability (along the supply chain), tradability, transparency, trust... e.g. CertifHy (very robust). Covering all sectors (transport, building, industry,...).
- There is a possibility of using distributed ledger technology to deliver the scheme (e.g. block chains); it is not mature yet but there is a lot of potential and should be ready by when the H2 market will materialize (> 2025). Should also encompass storage.
- It is also necessary to introduce certification scheme that addresses hydrogen-derived fuels using carbon as feedstock.

**Peter Styles, Executive Vice Chair of the EFET Board**

- The perspective should be cross-sectoral, cross-commodity, technology neutral approach, as far as possible (let's be cautious not to disturb the existing transparent well-functioning markets).
- Another guiding principle: carbon neutral or other concrete renewable sources are a mean to the end, which is zero-carbon economy, and not a final goal. So, certification should be covering as much as possible all carriers and sources.
- Gold standard is the ETS: level playing field across EU, not relying on national regulation, principle of non-interference with energy markets. Links exist already between RES and verification (monitoring regulation).

- Certification should be tradable independently from the physical substance; no to mass/energy tracking.
- Let's not partition the energy markets, trying to track electrons, molecules etc. would be overcomplicated. But EU certification scheme is a Yes.
- Double counting must be avoided.

**Sascha Wüstenhöfer, System Manager, ISCC International Sustainability and Carbon Certification**

- Yes, the certification system is now fit for purpose, several delegated acts should come in the coming months.
- The RED has demonstrated that specific sustainability requirements can be introduced for specific sectors, so dedicated regulation is possible.
- There are not many experiences with RED II effects since it is only being implemented
- There is also a large room for interpretation, so we need a clear legal framework, otherwise we may miss the opportunity to establish a level playing field. Therefore, the RED revision should pay attention to:
- Sustainability requirements for biomass: social sustainability aspects are missing (e.g. safe working conditions, child labour) – it works in some independent schemes already, so it is possible to integrate such approach.
- Traceability: Art 30: limited guidance on how it should be addressed, too much room for different interpretation (e.g. an „appropriate time period") – should be clarified or otherwise there will not be level competition across (certification) schemes.
- Principle of trust: define what to do with economic operators that do not abide with the regulation.
- Control and monitoring scheme of the certification bodies is needed. Otherwise, we might face the risk of a race to the bottom to avoid proper oversight mechanism.

**Javier Castro, Business Development Carbon Management Service, TÜV SÜD Industrie Service**

- The current system works well, however, the question of what happens when somebody is not conforming to the rules is not addressed, as well as some other operating issues;
- Why co-existence of 2 systems makes sense:
    - Mass balance system (focus on final consumption) is not feasible for electricity, e.g., tracing the electrons;
    - Book and claim (focus on production) would be too complicated for biomass e.g. difficult to link with the end use.
- There could be a possibility to transform certificates from GO to mass balance and vice-versa. This integration has to be integrated on EU level, or else there will be different national rules and the system will not work efficiently
- New system should be based on integration of existing systems.

**Sacha Alberici, Managing Consultant, Guidehouse**

- Benefits: providing auditors with timely data; limiting risk of bad transactions; support MSs and schemes in monitoring activities
- It should be complementary existing schemes
- Successful implementation requires cooperation with national actors
- Schemes would need to ensure that economic operators actually use the database
- Downstream supply chain is already familiar with similar databases, upstream sector however needs to be supported to learn how to use

In first step focus only on liquid and gaseous fuels in transport, but also hydrogen, biogas, bioliquids should be included to facilitate cross-border trade; later cover heating biomass, res electricity used for RFNBO production; but also including RES electricity generation would be step too far.

*Coverage of topics in Session 7 / Concluding remarks*

- Existing certification system delivered results, the question was about adapting it, given the emergence of new carriers, etc.
- Discussion on the scope & the content
- Need for a specific $H_2$ certification scheme
- Level playing field, technology neutral
- Certification should tradable, ideally independently of the commodity
- No tracing of electrons

*Concluding Remarks by Paula Abreu Marques*

Paula Abreu Marques concluded the session, by sharing the key takeaways that were summarised from the seven sessions held during the workshop. Some of the key points raised concerned:

- In order for the EU to achieve a 55% GHG reduction, increased ambitions in RE and energy efficiency are necessary. Increasing the share of renewables in the transport and heating and cooling sectors are key focus areas, although increasing the share of renewables in buildings and electricity supplies are also important.
- There is a need for stable regulatory framework with specific renewable energy and regulatory measures, which includes top-down EU governance rules to enable investments.
- Strong EU objectives are needed, at least doubling current ambition level of Heating & Cooling. A variety of heat sources, such as solar, geothermal, bio, are needed to replace fossil fuels.
- District Heating and Cooling are central for decarbonising Heating & Cooling and Energy System Integration at low-cost. Expansion and modernisation could be supported at the EU level to ensure a level playing field, fair competitiveness and investments.
- Local communities and cities are important actors to achieve EU and national goals, and should be enabled to effectively implement the REDII provisions. Clear communication of EU and national goals and integrated planning is also required to connect all levels of governance towards achieving the broader climate goals.
- During the workshop, there was a broad consensus on the need to step up efforts for promoting renewables in the transport sector. Rate of electrification of road transport is expected to increase, and will deliver important contributions. Harmonisation of policy instruments in REDII is desirable, but not full harmonisation. Some stakeholders expressed worries on policy certainty and investments over possible revisions of the REDII for the sector.
- In the industry sector, there remains a major growth area for RE deployment. Scale-up of cost-competitive renewable energy is critical to ensure competitiveness of EU industry.
- The polling exercise saw that a majority of the participants supported targets for renewables in the industry sector. Nonetheless, important barriers were also identified by panellists. Supporting conditions such as simplifying permitting processes, PPAs, state-aid guidelines, business model innovations and reduction of financial risks were seen as critical to ensure low-cost renewables.
- Renewable electricity remains central for cost-effective decarbonisation and unlocking renewable energy demand and consumer participation and electrification of end-use sectors is essential.

- Barriers to renewable electricity deployment need to be removed. This can be achieved through the implementation of the existing REDII and building on REDII provisions such as regional cooperation or guarantees of origins. Also, is important to coordinate with other works such as the European Taxation Directive review to ensure level playing field across sectors.
- Sustainable Bioenergy is important to reach carbon-neutrality, especially for hard to abate sectors. Bioenergy in the EU is a by-product of broader circular bio economy and has to be seen in this context. Confidence in the sustainability of EU bioenergy is an important requirement for wide-spread development, which will depend on Sustainable Forest Management, and the maintenance of forest carbon stocks and sinks. Industry and forest owners see REDII and LULUCF as important steps forward and call for stable regulatory framework to support investments. Meanwhile, NGOs are more critical and call for stricter rules. Achieving a balance would be important in the REDII review.
- Further development of certification system into a full-fledge certification would make a vital contribution to achieve ambitious energy targets. Adjusting the scope of the certification to cover all emerging fuels is important. Sector-specific certification could be necessary, for hydrogen, for example.
- There is a need to ensure that REDII will be fully and timely implemented, so policy continuity and stability is key. The REDII review should focus on areas where there is a clear need to enhance the provisions to link to the climate ambitions to the energy system integration and to other relevant policy documents and decisions that have been taken.
- This workshop is only a part of the stakeholder engagement planned for the REDII review. Stakeholders are welcome to provide their feedback via the Open Public Consultation (OPC), which is also opened till 9 February 2021. A second workshop is also planned to be held in Spring 2021, well before the adoption of the Commission's proposal which is scheduled for June 2021.

## Report of the 2nd Stakeholder workshop 22 March 2021

### *Executive Summary*

On 22 March 2021, the European Commission, DG Energy, held a second online event in the context of the work to revise Directive 2018/2001 on the promotion of the use of energy from renewable sources. The revision aims to ensure that Renewable Energy Sources (RES) cost-effectively and sustainably contribute to at least 55% Greenhouse Gas (GHG) emissions reduction in 2030, in line with the Climate Target Plan (CTP). This means reaching a 38% to 40% share of RES in 2030. The event was part of the wider consultation process on the revision of the Directive launched on 17 November 2020. Information on the review of Directive 2018/2001, the public consultation and the two stakeholder workshops is available online (at https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en).

The event agenda included 7 external keynote speakers[7] in three sessions. An official from DG Energy coordinated each session. The event also included an opening session from Kadri Simson, the Commissioner for Energy at the European Commission, a sharing of the first outcome of the open public consultation by Paula Pinho, Head of Unit ENER C.1 Renewables and Energy System Integration Policy, and closing remarks from Ditte Juul Jørgensen, Director-General, DG Energy.

The event was organised with the support of Trinomics which provided technical and content support to DG Energy. Over 1048 people from over 600 different organisations registered for the event. During the day of the event, 873 people connected via the Zoom platform for an average of 3 hours and 42 minutes.

### *Overview of the event*

This second stakeholder event for the revision of Directive 2018/2001 on the promotion of the use of energy from renewable sources (RED II) was held on the 22 March 2021 as part of a wider consultation process. The process includes a questionnaire which was open to any individual and organisation (available online at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001/public-consultation) as well as a first stakeholder event, which was held on 11 December 2020.

The event was organised by Trinomics as part of the contract ENER/ C1/2020-440 for *Technical support for RES policy development and implementation: delivering on an increased ambition through energy system integration.*

### *Agenda*

The event was organised in three sessions, split between morning and afternoon. As part of the agenda (see table below), Kadri Simson, the Commissioner for Energy at the European Commission, and Ditte Juul Jørgensen, Director-General at DG Energy, provided introductory and concluding remarks, respectively. Paula Pinho, Head of Unit C1, provided an introductory presentation of the results of the online Stakeholder Consultation, which closed on 9 February 2021.

The three sessions covered main areas of RED II, namely: *renewable energy in transport*; *renewable energy in heating and cooling, buildings and district heating*; and *sustainability of forest biomass for energy*. Each session was moderated by a DG Energy official responsible for the topic and gave ample time for keynote interventions and contributions from the public. The format of the event was agreed so that it would give maximum exposure to stakeholders'

[7] See Annex I for the profiles of each speaker

opinions and foster a debate among them. The event ran from 10h00 to 17h00, CET, with a 1.25-hour lunch break.

*Table 35 - Agenda of stakeholder workshop*

| | Agenda item | Moderator | Speakers |
|---|---|---|---|
| **Morning Session** | | | |
| **10h00** | ***Opening and introduction*** | **Kadri Simson,** *Commissioner for Energy, European Commission* | |
| ***10h15*** | ***First outcome of Stakeholder Consultation*** | ***Presentation by Paula Pinho,*** *Head of Unit ENER C.1 Renewables and Energy System Integration Policy* | |
| **10h45** | **Session 1 Renewable energy in transport** | **Bernd Kuepker,** *Policy Officer, DG ENER Decarbonisation and Sustainability of Energy Sources, European Commission* | *Keynote interventions*<br>• **Dr. Alexander Landia**, Chairman, The Mobility House AG<br>• **Prof. David Chiaramonti**, Polytechnic of Turin<br>*Interventions from attendees* |
| ***12h15*** | ***Break*** | | |
| **Afternoon Session** | | | |
| **13h30** | **Session 2 Renewable energy in Heating and Cooling, Buildings and District Heating** | **Eva Hoos,** *Policy Officer, DG ENER Renewables and Energy System Integration Policy, European Commission* | *Keynote interventions*<br>• **Brian Vad Mathiesen**, Coordinator of sEEnergies, Aalborg University<br>• **Oliver Rapf**, Executive Director, Buildings Performance Institute Europe<br>*Interventions from attendees* |
| **15h00** | **Session 3 Sustainability of forest biomass for energy** | **Giulio Volpi,** *Policy Officer, DG ENER Decarbonisation and Sustainability of Energy Sources, European Commission* | *Keynote interventions*<br>• **Sarah Mubareka**, Joint Research Centre, European Commission - *Presentation of JRC woody biomass study*<br>• **Prof. Jean-Pascal van Ypersele**, UC Louvain, former vice-chair of IPCC<br>• **Karoliina Niemi**, Forest Director, Finnish Forest Industries Federation<br>*Interventions from attendees* |
| **16h30** | **Conclusions** | Ditte Juul Jørgensen, Director General, DG Energy, European Commission | |

### *Organisation*

#### *Inviting participants and management of registrations*

Preparations for the event started just under one month in advance of the event. A first round of email with a "save the date" reminder was sent to 768 stakeholders on 2 March 2021, which informed them of the date and time of the second stakeholder engagement event. A second email to 807 stakeholders was sent the following week, on 12 March 2021, where the tentative agenda and the registration link to the online event was provided. A third and last e-mail was sent to 831 stakeholders on 19 March 2021, to provide them with an updated agenda, the profiles of the keynote speakers, and the same registration link for them to register for the event via Zoom.

The platform chosen for the event – Zoom – was selected based on its capability to support the high number of participants expected to attend the event. Registration was done directly via the Zoom registration platform.

#### *Agenda preparation and coordination with panellists, moderators and stakeholders providing interventions*

In preparation for the event, DG ENER identified and reached out to the seven keynote speakers, and confirmed their participation independently. Similar to the first stakeholder engagement event held on 11 December 2020, the moderator for each session was the responsible officials in

DG ENER C.1 and C.2. The project team had also reached out to keynote speakers and moderators on 16 March 2021, to provide them with their unique link to join the online event, a technical guide for using Zoom, and the opportunity to participate in any of the three technical dry run session that was scheduled between 17-18 March 2021, if they would like to. In addition, a dry run session was also specially organised on 17 March 2021 to orientate the core team from DG ENERGY to get accustomed to the functions of Zoom and the interface with Sli.do.

In the period between the first workshop and the second stakeholder event, the project team had received several requests from the public, asking the opportunity to voice their views and concerns in the second stakeholder event. To ensure these requests were accommodated, additional slots were planned during the event, while time was also provided for additional impromptu interventions during the event, ensuring a fair balance of positions.

A final e-mail to the keynote speakers was sent on 19 March 2021 which included an outlook invitation, together with the updated agenda, a compilation of the profiles of keynote speakers of the event, and speakers' unique weblink to join the event, along with other administrative details. A final e-mail was also sent to stakeholders who would provide short interventions on 19 March 2021, including the updated agenda, compilation of keynote speakers' profiles, as well as other administrative details.

*Questions from stakeholders via email*

Before the event, stakeholders were able to submit questions to the project's email address. These were shared with moderators in the document titled: *moderators' guide*. The questions received are included in Annex VII.

*On the day – behind the curtain event coordination*

Three staff members from Trinomics were managing various tasks to ensure the smooth and seamless running of the event on the day. Tasks included:

- answering emails from participants having problems to connect;
- registering several new participants that had not previously registered;
- explaining the housekeeping rules to participants of the event;
- following up on the inputs from attendees via the chat functions;
- time keeping;
- management of the slide-pack; and
- technical support for moderators and panellists.

Other members of the project team were also responsible for note-taking and support to moderators of the respective sessions.

*Post-event follow-ups*

The attendance report in Zoom, and a compilation of the questions received via Sli.do were downloaded at the end of the event. The slides that were used during the event were compiled and tidied up after the event. A thank you e-mail, along with a PDF copy of the slides, as well as the list of questions received via Sli.do during the three sessions was sent to workshop participants on 24 March 2021. An updated copy of the slides was sent to workshop participants on 31 March 2021 A copy of the slides for the event was also made available online (https://ec.europa.eu/info/events/workshop-revision-renewable-energy-directive-2021-mar-22_en).

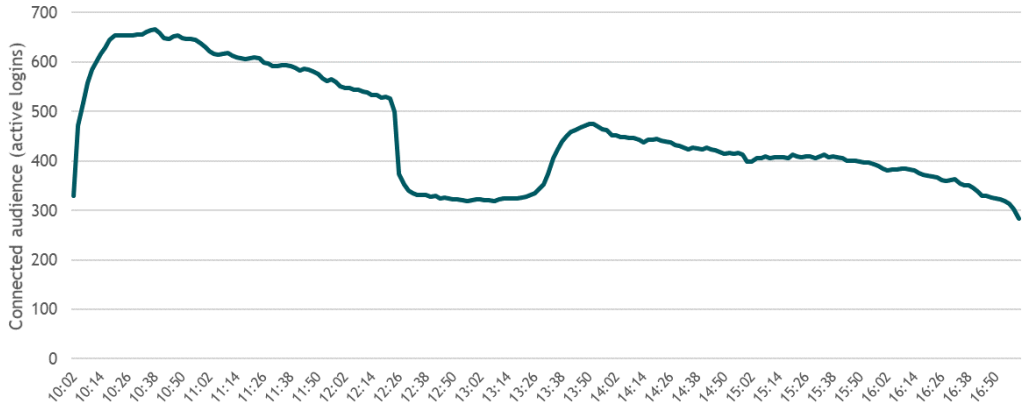
The minutes taken during the event were also consolidated from the task leads of the project team for each session..

*Attendance*

A total of 1048 people registered for the event either via the link provided or by sending a request via email. Of these, the total number of attendees was 873, of which 38 were moderators, panellists, and project team members. The remaining 835 participants were public audience. The attendance rate (share of registered people that connected to the event on the day compared to the total number of registrations) is 83%. On average, each attendee stayed logged in for 3 hours and 42 minutes, with several participants logging in and out multiple times.

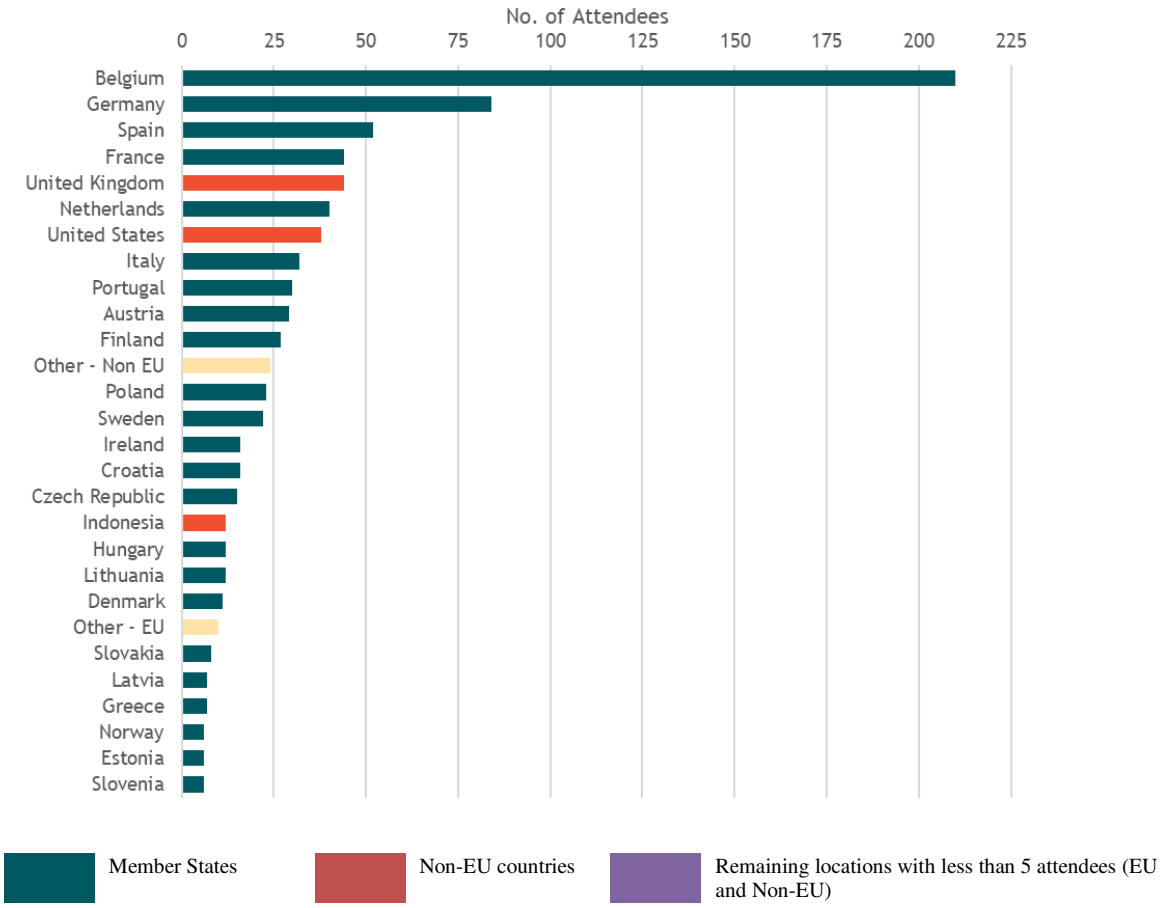
The figure below shows the number of active connections throughout the day of the event, from 10.00 to 17.00. The dip in the graph between 12:15 to 13:30 is the lunch break. Generally, attendance was higher in the morning session than in the afternoon session and peaked at just under 675 participants.

*Figure 65 Number of active connections*



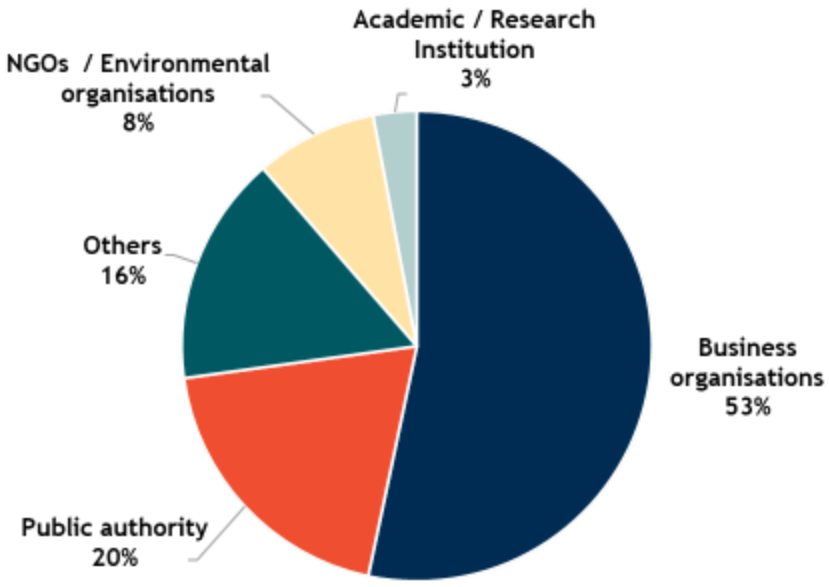

Most participants were from within the EU, with the majority connecting from Belgium, followed by Germany, Spain, and France. The high number of connections from Belgium reflects the number of lobby groups based in Brussels (bearing in mind this analysis excludes attendees registered with a *@ec.europe.eu* domain). Non-EU countries, such as the United Kingdom, United States of America and Others are highlighted in yellow and orange in the figure below.

*Figure 66 Location of attendees (excluding attendees from European Commission)*



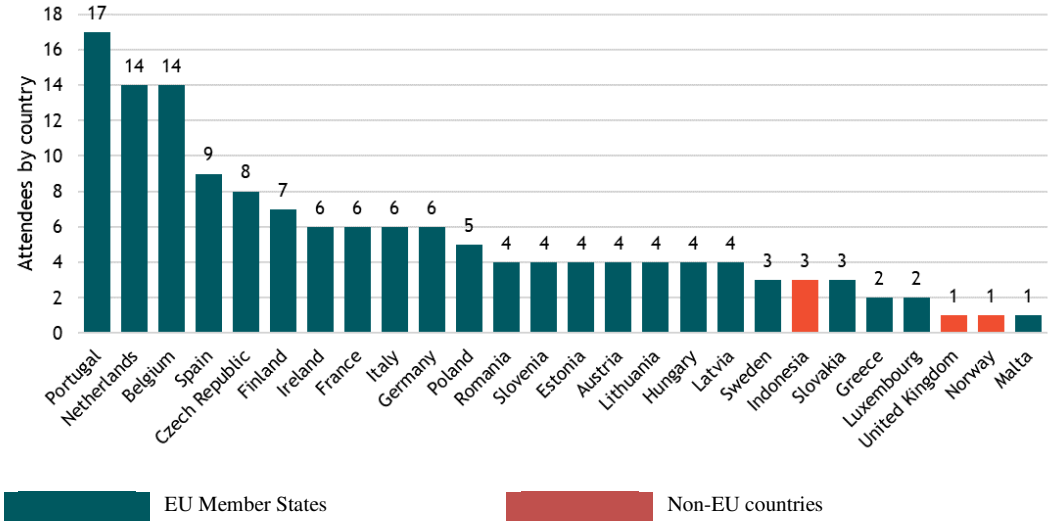

Over half of the attendees of the event came from business organisations (53%). 20% of the attendees represented public authorities, which includes officers from the European Commission. 8% came from environmental organisations and NGOs, 3% came from academic and research institutions, and 16% of the stakeholders fell under the *other* category.

*Figure 67 Affiliation of attendees (including attendees from European Commission)*




Among the 142 attendees who represented governmental organisations (central government and other governmental bodies, excluding EU institutions but including the permanent representations in Brussels), the countries with the most representatives were Portugal, the Netherlands and Belgium. No representatives attended from the governments of Bulgaria, Croatia, Cyprus or Denmark.

*Figure 68 Public authorities by country (excluding attendees from European Commission)*



*Opening and introduction by Kadri Simson, Commissioner for Energy*

The event started with the opening address of Kadri Simson, *Commissioner for Energy,* European Commission. In her remarks, Kadri Simson referred to the large amount of interest in the revision of the Renewable Energy Directive by stakeholders, with almost 39,000 responses to the Open Public Consultation (OPC). These responses came from all sectors: citizens, business associations, companies, public authorities, environmental organisations and NGOs.

From the conclusions drawn from the OPC, the European Commission started identifying a way forward towards a legislative proposal that will come in June in the Fit for 55 package. The context of this work is well known: Europe wants to be the first climate neutral continent by 2050, making renewables the main pillar of the EU energy system. In order to reach the EU targets, the renewable energy sector needs to grow by 15-20% annually. Electricity produced by renewable sources exceeded that produced by fossil sources for the first time in 2020. However, the supply today will not be able to match the future demand. Expanding the renewable energy sector is an opportunity for European industries and companies cleaners and more competitive. Further, climate ambitions will require investments in renewable energy of 350 billion euros per year.

Supporting the green transition and investing in renewable energy is at the core of many EU initiatives, including the Next Generation EU Plan and the Recover and Resilience Plans. Europe is showing global leadership by contributing fuly to the aims of the Paris agreement, The Fit for 55 package will include changes to the Emissions Trading System, Energy Taxation Directive and Energy Efficiency Directive.

While Member States do make use of the current EU policy framework to increase the use of renewables, it will not be enough to raise the share of renewable energy to 38—40%, which is needed to meet the increased climate ambitions under the Green Deal and the Climate Target Plan (goal of reducing EU's greenhouse gas emissions by 55% by 2030). The Commissioner therefore underlined the need for important additional investments on renewables and the fact that REDII revision will focus on sectors that need more attention, such as transport and heating & cooling, to bring the Directive in line with the ambition of the Climate Target Plan. Particularly, this includes the transport and heating and cooling sectors. As of 2019, only 8.9% of the energy used in the transport sector is produced from renewable sources. The impact assessment shows that the share of renewables in that sector will need to increase to 24% by 2030. This will require a transformation of the transport sector. Charging infrastructure and secure access to batteries will be critical to the roll out electric vehicles. Clean hydrogen will be crucial to decarbonise aviation and maritime. Further, advanced biofuels will need to be promoted more. The 2018 Renewable Energy Directive set the first targets, but these will need to be revisited in light of the higher 2030 ambitions.

The decarbonisation of the buildings sector is vital to meet the 2030 targets. According to the impact assessment, Member States should reduce GHG emissions from buildings by 60% compared to 2015 levels. The European Commission will also look into measures to increase the use of renewable energy in the industry sector, which accounts for 26% of EU's energy consumption, in particular the chemical, iron and steel sectors.

One of the main concerns raised by stakeholders regarding the use of bioenergy is that it could lead to unsustainable forest management practices with a negative impact on biodiversity. Sustainability criteria were introduced in the last revision of the Renewable Energy Directive, which will start to apply in 2021. The draft implementing act will be published soon (est. June 2021), and it will be subject to a four-week open public consultation period.

However, this may still not be enough. Therefore, the European Commission is looking at targeted changes to the sustainability framework in the context of the revision of RED II. The EU

objective is clear: EU and national legislation should support only sustainable practices and avoid those with negative impacts on biodiversity.

In the concluding remarks of Kadri Simson, the Commissioner for Energy, European Commission, she thanked stakeholders for their contributions and interest. She remarked on how there is a clear and unambiguous support to raise the EU's ambitions and increase the share of renewables in the EU. She looks forward to an ambitious proposal to be announced in June this year in 2021.

*Outcome of the Open Public Consultation by Paula Pinho, Head of Unit, DG ENER.*

Paula Pinho, Head of Unit ENER C.1 Renewables and system integration, European Commission, presented the first outcome of the Open Public Consultation (OPC). As part of the OPC process, the European Commission launched a questionnaire to collect the views and suggestions from stakeholders and citizens concerning the RED II. The questionnaire, which consists of 54 closed questions and 42 open questions, was uploaded on the EU Survey Platform at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001/public-consultation). The OPC was open for 12 weeks, from 17 November 2020 to 9 February 2021. In conclusion, the European Commission is grateful for the contributions that stakeholders have provided. The OPC will help the European Commission in their preparatory work on the revision of RED, particularly in identifying what the main issues and concerns are.

## *Session 1 Renewable energy in Transport*

*Table 36 - Details of Session 1*

| Time | Moderator | Panel |
|---|---|---|
| 10h45 –12h15 | **Bernd Kuepker,** *Policy officer, Decarbonisation and Sustainability of Energy Sources*, DG Energy, European Commission | Keynote interventions<br>• **Dr. Alexander Landia,** *Chairman*, The Mobility House AG<br>• **Prof. David Chiaramonti,** Polytechnic of Turin<br>Interventions from attendees<br>• **Antonella Rossetti**, *Senior Advisor*, Farm Europe<br>• **Claude Mangin,** *Market Development Manager*, ENTSOG<br>• **Eric Sievers,** *Director of Investments,* Ethanol Europe<br>• **Harmen Dekker,** *Director,* European Biogas Association<br>• **Ilkka Räsänen,** *Vice President, Public Affairs*, Neste<br>• **Marko Janhunen,** *Director*, Public Affairs, UPM<br>• **Xavier Noyon**, *Secretary-General*, European Biodiesel Board<br>• **Emmanuel Desplechin,** *Secretary General*, E-pure<br>• **Felicia Mester,** Senior Policy Advisor, Hydrogen Europe<br>• **Laura Buffet,** *Energy Director,* Transport and Environment |

*Summary*

The share of renewables in the transport sector should be increased and efforts should be intensified in this field. Energy system integration as a whole is important, and would require a more consistent implementation by Member States (MS). Biofuels, hydrogen and electrification are all important to meet the decarbonization goal, since some sectors (for example aviation and maritime) will not be covered by electrification in the short and medium term. The importance of high volume biofuels was also highlighted in the keynote intervention of Prof. Chiaramonti. However, the views of stakeholders on the role of the available options for transport decarbonisation and in particular the role of conventional biofuels differed. The need for new technologies and boost in research and development (R&D) were also underlined, where the revision of Annex 9 part A of RED II was highlighted by a number of stakeholders. Others underlined that regulatory stability was important.

*Position of keynote speaker Dr. Alexander Landia, Chairman, The Mobility House AG*

- National implementation is a main obstacle today (it is a patchy picture).
- We need to think broader - beyond mobility and consider energy integration as a whole.
- The question is how to charge a large amount of electric vehicles (EVs)? We need to turn this into a solution: How to provide flexibility for energy system.
- Vehicle-to-Grid (V2G) integration is a key factor for successful and sustainable transport and energy transition.
- The daily flexibility needs of RES compared to contribution that EV batteries can make to this. Based on conservative assumption: EV batteries can contribute 1/3 of daily flexibility needs by 2030, more than 100% by 2050.
- Suggests three ways to do so:
    1) Smart-charging (you select when you want to charge your battery, e.g. 2 hour window while parked for 10 hours);
    2) V2G, the car is giving back power when needed;

3) Second life batteries after they reach 80% capacity—they can be perfectly used in stationary storage.

- The volume is very large and the costs are relatively low, because batteries have been paid for by driving already. This will result in lower costs than pumped hydropower or gas turbines.
- Put consumers at the heart of transformation of the energy system by allowing them to earn money on their contribution and reducing emissions. Consumers can earn about 1300€ per year and reduce emissions by 4t $C0_2$/annum/vehicle at the same time. This is an example from Germany.
- Volkswagen will offer its first bi-directional charging for their vehicles in 2022. This may increase consumer interest who may ask for updates in regulation in order for them to tap into this economic incentive.
- Currently, promoting electric mobility is done through the provision of subsidies which are costly. The car owners, who have received subsidies, are not motivated to provide the services of their batteries to serve the grid. If these batteries are not used for grid services, half of the capacity guaranteed by original equipment manufacturers (OEMs) will be wasted.
- Our proposal is to introduce smart regulation to enable the use of batteries for grid services, to enable consumers to earn money by driving with green power, and if they are able to earn revenue (1300€/year), this could be securitized through a green bond or loan. That would be an upfront potential payment on power with current share of German states in the purchase subsidies.
- In Germany, the 2,500 batteries that are managed by Mobility House were able to deliver about 4% of the daily flexibility needed by the European grid system on 8 Jan.
- A massive contribution of EV batteries is possible at very low costs.
- RED II did not specify that you need to calculate the specific contribution of any source of fuel in a certain way, and is dependent on the interpretation of the national governments. In our view, the current German methodology underestimates the contribution of electric cars and e-fuels by 13 times.
- There is a need to measure the real contribution, which is possible.
- There is a need to create a level playing field for aggregators, like Mobility House, for example.
- There is also a need to avoid car manufacturers working in silos building car batteries without sharing information. Proposes for open systems, multi-OEMs, multi-vendor, multi-operator, which are able to operate across the EU.
- It would be great to have reliable data from network operators on $CO_2$ footprint of power in the system and the share of renewable energy used.
- The moderator asked Dr. Landia if further actions are required to ensure correct implementation of existing provisions , or if he could go in further detail in this regard. There is a need for more R&D and rules for car manufacturing. There is a need for European manufacturers to agree on the standard for manufacturing cars to facilitate bi-directional charging.
- The moderator sought to clarify with Dr. Landia the question of implementation of the RED II. Do questions pertain to ensure correct implementation of existing RED II or is there a need to set out some rules in more detail to ensure proper implementation. What kind of rules would be required? In response, Mobility House said that they have produced a set of rules for Germany, as these are country specific. These include, for example, rules regarding R&D and more guidance for car manufacturers, for example by agreeing on the Combined Charging System (CCS) standards, a software standard, for bi-directional charging vehicles. EU car manufacturers would need to agree on this standard before manufacturing cars. Another example is the need for calibrated metering /smart metering, which can reduce the earnings of EV owners. There need to be rules to build a reliable database

sharing information between EV batteries and OEMs, in order to avoid the need for installing this additional smart meters.

*Prof. David Chiaramonti, Polytechnic of Turin*

- All fuels and feedstocks are needed to achieve targets.
- RED II is one important policy in the portfolio of complementary policies, such as the European Emissions Trading System (ETS), Effort Sharing Regulation, waste policies, Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) etc.
- Insights from RE-CORD project on biofuel scenarios and market perspectives:
  - Massive market uptake of industrial-scale lignocellulosic and electricity-based fuels expected after 2030/2035.
  - RED II Annex IX A-B: RES-T greenhouse gas emissions savings of 24% by 2030 is not sufficient
  - Land use: Good soil practices are possible and beneficial.
- 2030-2050 scenarios:
  - All renewable options need to be deployed in parallel to deliver scale-up to long-term ambitious goal.
  - Ambitious and stable (long-term) supporting policies.
  - Curtailment of fossil fuels to further foster renewable uptake?
- Biofuels under pressure from climate-constrained future => water deficits increasing!
- Biofuels have to become part of a circular economy.
- Biofuels can contribute if well-designed and integrated in a circular sustainable development models.

*Summary of interventions from attendees*

**Antonella Rossetti,** *Senior Advisor,* Farm Europe

- According to their study, biofuels produced from European crops have not replaced EU food production. Biofuels contribute to the development of rural areas.
- Renewable energy progress report: no correlation has been observed between food prices and biofuel demand. At the same time, we see that the Commission persists with its attempt to limit the contribution of EU biofuels with a negative narrative.
- We need to understand on what basis the Commission is assessing and reviewing the cap on biofuels.
- Clear policy distinction needed: sourced from EU vs. imported (often from deforested areas).

**Claude Mangin,** *Market Development Manager,* ENTSOG

- Would like to extend RED II scope to low carbon fuels because it can help decarbonize.
- Understands that some stakeholders are *afraid* of this but declares good intention.
- Simplify and harmonise accounting based on point of origin. Need clearer sub targets.
- Not in favour of additionality principle.

### Reaction from keynote speakers

**Dr. Alexander Landia,** *Chairman,* The Mobility House AG:

- Agree that all technologies are required to reach the targets.
- Internal combustion engine used for conventional biofuels or hydrogen has a very low energy efficiency.
- Current Fuel Cell technology from green electricity inputs have an energy efficiency of about 35%.

- If used directly in a battery electric vehicle (BEV), a 70-90% efficiency can be achieved.
- In the long term, there will be a clear way on how to this. On the way there you need all of it, because there are areas where you cannot use batteries, for e.g. in the aviation sector.

**Prof. David Chiaramonti,** Polytechnic of Turin**:**

- It is a multi-discipline consideration. Well-designed biofuels can be carbon negative. The Paris COP 21 heard a continuous request for carbon negative actions because carbon neutrality is not sufficient to meet the high climate targets set. This, combined with the curtailment of fossil fuels, is the single action that will help.
- How much value do you give to fighting desertification and drought versus greenhouse gases emissions savings? They work together, and there is no need to prioritize one over the other, but instead, to prioritize those technologies that addresses both, e.g. multi-year agriculture. There is a big opportunity to address many positive impacts with multiple instruments in the same value chain.
- In that respect, ETS has been mentioned. ETS is also under revision, there is a consideration for nature-based solutions. This can be very well integrated with the sustainable biofuel value chain. There is an opportunity but problem: hard to harmonize. We should not see this as problems but as a significant opportunity to boost these impacts.

**Eric Sievers,** *Director of Investments,* Ethanol Europe

- RED I was a 'total failure' to biorefineries; RED II has improved to this end but not yet triggered any major investments.
- There is no 8.9% renewable share 2019 in Europe as this figure is after multiple counting;
- Criticises Dr. Chiaramonti, EC and consultants supporting the EC for lack of expertise in biofuels;
- Fantasies defy markets (refers to intervention by Antonella Rossetti, Farm Europe);
- Prices are falling;
- Full intervention available as an op-ed on euractiv: https://www.euractiv.com/section/all/opinion/why-red-iii-will-fail-just-as-three-renewable-energy-directives-have-already/

**Harmen Dekker,** *Director,* European Biogas Association

- Recent reports over the last two years. Biogas potential is very high. We can cater to 30-40% renewable gas supply, besides green hydrogen, produced in a true circular way.
- It is not about the engines, but about the fuel. The risk of not stimulating biomethane is not meeting the targets for curbing the methane emissions. There is a need to make sure that there are enough sustainable fuels also for mobility. It should be stimulated also on the vehicle side.
- Five points:
  - Biomethane in transport should be recognized on an equal basis to BEV in lifecycle analysis. It should at least be acknowledged as a zero emission fuel.
  - RED should not be used for low carbon fuels.
  - Agreeing with Landia, sectorial targets should be increased. Removing multiplier should be seriously considered.
  - Biomethane is not only a renewable fuel which is already available and supplying negative emissions in the transport sector. It can also be available to cater for the maritime sector, and as a heavy-duty fuel.
  - Lastly, a target on renewable gas (11%) is needed to make sure biomethane and green hydrogen are taken up in the future.

**Ilkka Räsänen,** *Vice President, Public Affairs,* Neste

- There is a need to reduce emissions, and all measures are needed to be able to achieve the target.

- By 2030, 90% of heavy-duty vehicles (HDV) and 80% of private vehicles will run on diesel. The need to address 80% of the fleet should be a priority. Other solutions will emerge over time.
  - Will there be enough feedstock to raise ambition level set by the IEA, for example? Yes there is enough feedstock. There is availability and potential. The previous RED revision already sets caps on food and feedstock and started ILUC to mitigate risks.
  - Industry is still investing a lot. There is a need for research and investment. There is also a need to raise ambition level and current feedstock pool.

**Marko Janhunen,** *Director, Public Affairs,* UPM

- Taking the point of view of an investor, there is a strong need for enabling regulation. There is also a need to limit the changes to the current directive to reduce the risk of regulatory uncertainty for investors.
- Should there be a revision of Annex 9 Part A, it will bring the risk of creating chaos.
- Regulation is key and little details are extremely important. The revision is an opportunity to put things in the right place.

## Reaction from keynote speakers

**Dr. Alexander Landia**, *Chairman*, The Mobility House AG:

- Observations: 6% GHG reduction in transport in Germany was impossible to be fulfilled by biofuels. 1% gap was filled by EVs and other contributions. Biofuels were unable to deliver 6%.
- On the other hand, the price of biofuels is driven by palm oil prices in Indonesia.
- If we have a chance to increase the share renewable by simply having electric cars on the street and recognizing their contribution 1:1 without multipliers, we can compare that to the contribution of biofuels and then make this comparison to the price.

**Prof. David Chiaramonti,** Polytechnic of Turin**:**

- *To Erik Sievers*: What I tried to show is the biorefinery approach. The point is that any sustainable model should be promoted. Sustainability goes way beyond greenhouse gas emission reduction only, and beyond the scope of RED. The view should be broad and include all the possible benefits following the green deal approach. Conventional crops in well-designed chains could contribute.
- *To Harmen Dekker*: Fully agree on your comment. I mentioned earlier about gas for climate, and the potential there for heavy transport is perfectly fitting into sustainability concept on agricultural sector that was introduced earlier during my intervention.
- *To Marko Janhunen*: Very relevant. In legislation, details are also important , e.g. measurement of carbon in soil. The solutions must be doable to deploy systems and not add burdens when it comes to implementation because it hampers investments. It is possible today. We would not build anything without a sound combination of measurement and modelling. It is normal practice to combine measuring and modelling.

**Xavier Noyon,** *Secretary-General,* European Biodiesel Board

- The European Biodiesel Board represents a range of biofuels, and has an awareness of various sectors, including road, heavy-duty vehicles, aviation, maritime.
- Beyond the sustainability issues, it is also very important to take into account public acceptance. It is a difficult task for the legislator address all the various views of the population.

- A stable framework and recognition are beyond doubt very important. It is very important for investments and for the development of the industry to have stability in the regulation.
- We already work with farmers on soil quality. We think that simple bans or simplistic solutions and categories that do not match existing notions on feed/food crop, and is not constructive. We are ready to look at issues seriously, but there is a need a better and more appropriate categorisation.
- Important to continue to develop biodiesel and to consider its role in decarbonisation. The development of biodiesel is not contradictory to the political decision to develop electric vehicles.
- In deploying those solutions and other measures, such as the limitation on feedstock, these can have a negative impact on the aviation sector, which would need to rely on sustainable biofuels to decarbonise. It can also lead to devastating effects for the deployment of biofuels for road transport in the near future. This is a complex debate with no simple solutions.

**Emmanuel Desplechin,** *Secretary General,* E-pure

- Supports the European green deal ambition.
- Increased targets and pushing biofuels.
- We must ensure that the targets and sub-targets are met and are not undermined by future revision.

**Felicia Mester,** *Senior Policy Advisor,* Hydrogen Europe

- Significantly revising upwards the 14% renewable fuel obligation (Art. 25) with a specific dedicated target for renewable fuels of non-biological origin in the transport sector (similar to the 3.5 % target for advanced biofuels provided by Art. 25.1 (b)) to level the playing field.
- The application of multipliers (Art. 27.2) (without a corresponding upward revision of the target, when the Directive was negotiated) has made the 14% a target almost irrelevant or very easily attainable (statistically) in many EU countries from the moment the RED II was adopted. Therefore, we advocate for a revision of the multiplier system.
- Renewable energy sub-targets and multipliers need to be mutually reinforcing as one provides a push in supply and the other creates a pull effect. This is currently not the case.
- When developing legislation and proposing targets and incentives, it is important to avoid duplication of efforts; as such, if specific sectoral targets, for e.g. in industry, maritime or aviation, are proposed within the context of RED revision, they should always be coherent with any other more specific and targeted sectoral legislative initiatives e.g. ReFUEL in the maritime and aviation.
- Specific sub-targets for these energy intensive sectors (e.g. steel production, aviation and maritime) should be considered in the upcoming revision of the RED to further incentivize and speed-up deployment and adoption of renewable energy.
- We have repeatedly raised our concern on the principle of additionality as defined today. It is the single highest regulatory barrier holding back renewable hydrogen deployment in Europe today. We welcome the work of the Commission on the Delegated Act.
    - The effect of additionality applied only to hydrogen producers is detrimental to the market uptake and deployment of renewable hydrogen, and with it, the demand for more renewable energy.
    - Holding renewable hydrogen producers responsible for the residual mix of the electricity system in a particular country is deeply unfair. No other consumer of renewable energy is subject to such conditions in order to be able to claim renewable character. Applying additionality criteria only to hydrogen producers is as such, highly discriminatory.

    - It ignores the basic economic rules of supply and demand: renewable hydrogen creates exclusively demand for renewable energy. More demand for renewable energy leads to more supply of renewable energy. This is a basic economic principle. Happy to explain in detail why.
    - The fears themselves are exaggerated, as most of the production of hydrogen using non renewable energy delivered by the electricity grid will only happen in the initial stage of market development, will be scattered across Europe, and, in relative terms, will be a drop in the ocean compared to the size of the electricity market. Any possible negative impacts that may occur will be small and short lasting.
    - Even if the effect of connecting electrolysers to the grid would be to inadvertently generate demand for fossil-based electricity (NB. please remember that renewable energy producers generate demand exclusively for renewable electricity), the net effect would actually be positive in a significant number of countries, and the sector where the hydrogen would be used. Here again happy to share further info and our data.
- Hydrogen as a distinct energy carrier, separate from electricity and gas. As such, conversion from one energy carrier to another must be transparent to the consumers.
- Guarantees of Origin (GOs) must include (1) the primary energy sources (full disclosure of sources) and (2) the greenhouse gas emission footprint.
- GOs need to capture the attributes resulting from different production pathways.
- It is becoming clear that in order to account for transport targets we will need imported hydrogen. An international GO system is required for import and export of hydrogen.
- Conversion from H2 GO to Gas GO as the two are not interchangeable.

**Laura Buffet,** *Energy Director,* Transport & Environment

- The main point of the revision of the RED is to shift design to not only focus on liquid fuels but also towards zero-emission technologies such as renewable electricity.
- Touches on four points:
    - Biofuels: All crop-based biofuels should be phased out by 2030 from RED II, high deforestation with biofuels including palm oil should be phased out much earlier, e.g. 2021. Advanced biofuels need stronger safeguards within the RED framework.
    - Renewable Electricity: The RED is not really designed to fully accommodate its potential. We really encourage the Commission to introduce a dedicated credit mechanism at the EU-level to make sure the potential of renewable electricity is fully reflected in the revised RED targets.
    - There has been some indication from stakeholders, and the Commission to broaden the scope of RED to include on low carbon fuels. T&E is strongly against it. Important for RED to focus on renewables. Regarding hydrogen, they should be made eligible only when produced from renewable electricity with clear additional requirements.
    - Regarding overall transport target, T&E agrees on revising the target. However, the target of 24% is too high. We advocate for a lower target, but there is a need to focus on the quality of the fuels and the environment integrity of the fuels, rather than on the quantity of the fuels. There is also a need to reflect the environmental impacts on the use of these fuels.

- Adjusting targets
- Potential of EVs and BEVs
- Need for a consistent, simplified and harmonised way to measure greenhouse gas emission reductions across technologies
- Bioenergy/Biofuels
- Low carbon fuels

### *Session 2 Renewable energy in Heating & Cooling, Buildings and District Heating*

*Table 37 - Details of session 2*

| Time | Moderator | Panel |
|---|---|---|
| 13h30 –15h00 | **Eva Hoos,** *Policy officer, Renewables and Energy System Integration Policy,* DG Energy, European Commission | Keynote interventions<br>• **Brian Vad Mathiesen**, *Coordinator sEEnergies Europe*, Aalborg University<br>• **Oliver Rapf**, *Executive Director,* Buildings Performance Institute Europe (BPIE)<br>Interventions from attendees<br>• **Michael Villa**, *Executive Director,* smartEn<br>• **Paolo Basso,** *Policy Director*, EHI<br>• **Paul Voss, Managing Director**, EHP<br>• **Jaume Loffredo**, *Energy Policy Officer*, BEUC<br>• **Sanjeev Kumar**, *Head of Policy*, EGEC<br>• **Thomas Nowak**, *Secretary General*, EHPA<br>• **Pedro Dias**, *Secretary General*, SolarHeat Europe |

*Summary*

The high expectations and potentials for decarbonization in the heating & cooling, buildings, and district heating sectors were discussed, with the Energy Efficiency First principle and the sustainable supply chains of heat as the core aspects. Among others, efforts should be made to accelerate district heating, combined with stimulating the uptake of individual heat pumps in rural areas. Particular attention should be given to thermal storage linked to heating & cooling (H&C), not only to the storage of electricity. Smart thermal grids are needed besides smart electricity grids. The study presented by Oliver Rapf (BPIE) shows the potential of renewable energy in the building sector and its role should be increased with targets—in the range of 53% RES (heat + electricity) in final energy demand by 2030. Therefore fossil fuels should be replaced by renewable electricity for heating, cooling and hot water. Reflection points for RED II include: increasing the annual target for the share of RES in H&C, increasing electric and thermal storage capacities in buildings, and making use of flexible energy demand management systems in buildings. A more integrated approach and planning is needed to support the growth of RES in buildings, therefore long-term renovation strategies should be included in the EPBD revision. This would require the increase of deep renovation rate, the application of stringent definition, implementation of national Nearly Zero Energy Building standards, and integrated planning to combine buildings efficiency strategy with renewable H&C supply strategy. The outcome of the discussion saw a need for a more ambitious and binding H&C target, and the need to foster demand-side flexibility, electrification, hybrid solutions, the strengthening of replacement obligations and more funding for renewable district heating and cooling (DHC).

*Position of each panellists Brian Vad Mathiesen, Coordinator of sEEnergies Europe, Aalborg University*

- sEEnergies projects (see https://www.seenergies.eu/), is a continuation of Heat Roadmap Europe.
- In individual MS, H&C makes for more than 50% of the final energy demand, and must therefore be the focus. Heating in all MS is more important than cooling.
- The scenarios in Clean Planet for All (1.5 TECH and 1.5LIFE) do not address a high ambition on DHC, relying too much on gas and Power-to-X (P-to-X) (which is counter-intuitive), with unrealistic energy efficiency targets in buildings. Particular attention should be given to thermal storage linked to H&C, not only to storage of electricity, which is more expensive. Smart thermal grids are needed in addition to smart electricity grids.
- Energy efficiency in scenarios from 100 kWh/m2 to 40 kWh/m2 is problematic. The 2030 level is much more realistic.
- Bioenergy is really problematic. Do not replace coal with biomass in combined heat and power (CHP), and not to replace individual heaters with biomass boilers! Biogas is another matter, it can be used in CHP.
- Tesla Powerwall should be banned (EUR 300/kWh) if we want to have a cheap integration of renewable energy. It is cheaper to invest in thermal, and bigger energy storages!
- Lots of heat is wasted because we do not have a district heating network. Waste Heat (WH) can cover half demand of DHC (where available).
- Those countries that have natural gas predominantly (UK, NL) have low penetration of renewable energy in heating but the inverse is also true. Positive correlation between district heating and renewable uptake.
- Need a lot more DHC, a lot energy savings, and also need to distinguish between cities and rural areas. For buildings we need to look at building (?) renovations, saving energy etc
- In the future we need a smart energy system – not only electricity but also smart thermal grids.
- We need to ramp up the investments in new district heating and cooling in Europe if we want to decarbonise Europe in a cost-effective manner.

*Recommendations:*

- Heat pumps in buildings - increase in share from 1% to half of the heat market mainly in rural areas.
- District heating supply increase from 12% to cover the other half of the heat market mainly in urban areas.
- Individual fuel boilers and electric heating for heating should be limited as far as possible
- All natural gas boilers should be phased out.
- Hydrogen is not for heating buildings.

*Oliver Rapf, Executive Director, Buildings Performance Institute Europe (BPIE)*

- The building sector must reduce GHG by 60% by 2030. How do we come to the -60% GHGs? Report is available online at https://www.bpie.eu/publication/on-the-way-to-a-climate-neutral-europe-contributions-from-the-building-sector-to-a-strengthened-2030-target/ , where the work presented is based on model developed under Horizon2020 project.
- RES heat + electricity to 53% and for heat: 32%. These numbers are based on looking at just heating, cooling and hot water demand.

- Need to make sure that within the coming decade we reduce energy demand by 24.8% which is the enabling condition to allow for increasing renewables.
- Modelling shows that the decrease of fossil fuels should be larger than renewables because energy efficiency is essential (see figure below).
- Policy design is based on modelling target for H&C need to come to 3.7% under Art. 23 of RED II
- Need significant storage electric capacity and increasingly thermal storage (including in buildings): better insulated, higher efficient buildings. More flexible energy demand system. Integrate the respective tech. There are strong link with the Energy performance of buildings directive (EPBD), a more integrated approach is needed.
- How can we foster energy positive districts and buildings? Buildings could become an energy source.
- Sees a current disconnect between renewable energy supply to building sector, and the decrease of energy consumption of the building sector – this would require better integrated planning to meet the higher climate targets. The relevant policies would need to be considered along with the revision of RED II.

**Michael Villa,** *Executive Director,* smartEn

- Smart renewable electrification in buildings and transport sectors could be interoperable. This is in line with the energy system integration strategy.
- In order to help integrate more variable RES generation in the system in a cost-effective way, in addition to reducing energy consumption or energy efficiency measures, making consumption more flexible could help. This would require an evolution of the energy system concept from a static to a dynamic one. This would increase system efficiency. This would not only benefit end-users, but also offers flexibility for the energy system. Therefore, there is a need to activate greater flexibility.
- Example of Norway by 2030 -> even if EVs are charged in buildings, energy demand will increase by 3.5% rather than doubling. -> extremely important that RED fosters supply and demand flexibility in all user sectors.

**Paolo Basso,** *Policy Director*, EHI

- Agrees that addressing heating will go a long way in decarbonising buildings. In Europe, the vast majority of heating equipment is old and inefficient and has to be replaced faster than it is today -> part of renovation wave.
- Hybrid technologies have a role to play -> present advantages to realise system integration, low intensity on budgets and buildings & grids.
- Decarbonised and renewable gases have a role to play -> at this stage there is no more talk about fossil fuel technologies for heating, the appliances can use renewables and hydrogen for heating.
- Thermal storage is important. We know thanks to the modelling that there will be a role for each tech.
- EHI supports a RED II target of 38 to 40%. They would like to see a clearer role for hybrid heat pumps under the RED II as well as minimum targets for buildings and large renovation.
- In favour of increasing the 1.3% target and making it binding.
- Renewables gases and renewables electricity should count for the heating and cooling

**Paul Voss,** *Managing Director,* EHP

- Review of RED II should be looked at in conjunction with discussions on the Energy Performance in Buildings Directive (EPBD) and the Energy Efficiency Directive (EED). Experience in market for district heating has developed well. Emergence of sector integration is very helpful. District heating can help to find an appropriate role in the system for renewable electricity, and also for renewable decarbonised gases to balance the electricity system, and to be used in CHP.
- Currently, district H&C still uses plenty of fossil fuels, in a more integrated system we should be able to help but also be helped through integration of more renewables. District heating can help tie all things together and avoid using more precious resources like electricity or hydrogen.
- Hydrogen should be kept out of residential heat.

**Jaume Loffredo,** *Energy Policy Officer,* BEUC

- Need clear decision of where to go, how to get there, and how to do it efficiently. Legislation (the "how"): binding H&C targets. Getting there: planning – plan where to put DHC, heat pumps -> very important for consumers, they do not know what they should be buying at the moment due to lack of clarity.
- Low carbon hydrogen has no places in residential heating -> more costly and less efficient.

**Sanjeev Kumar,** *Head of Policy*, EGEC

- Fossil fuel subsides going into H&C must be eradicated. It is important that non-renewable technologies are excluded from RED II.

- District heating has a significant role to play because we have to decarbonise fast. Funding to district heating systems needs to increase. As a reference, list of Projects of Common Interest (PCI) allocated 29 billion euro to fossil infrastructure. We would like to have at least the equivalent for district heating under the revision of the PCI list
- For technologies like geothermal -> risk insurance, need to de-risk large projects with high Capital Expenditures (CAPEX) (geothermal, ocean etc). Art. 3.5 of RED II instructs MS to reduce CAPEX, however, it is better option to put a risk scheme at European level than to put the burden on Member States, as it is at the moment.
- Cooling is very important -> adequate attention is needed.
- Rural communities cannot be left behind. Need dedicated programme to rapidly decarbonise.

**Thomas Nowak,** *Secretary General*, EHPA

- We have enough solutions available, Heat Pumps are an important one. Need to start soon, heating and cooling sector is quite slow. Start now and push for solutions that are available now and then see what happens. 60% of existing buildings can be retrofitted with a Heat Pump without need for renovation.
- 3.7% target -> needs to be supported from the policy side to avoid ambiguity on which solutions to take.

**Pedro Dias,** *Secretary General*, SolarHeat Europe

- Having an opportunity to make a change. 2030 is a milestone, and whatever is installed by 2030 will be there in 2050 (assets with long life time). This is the decade of transition to decarbonise heat.
- Promote measures that will help consumers in the transition. High upfront costs but lower operational ones and pull and push measures. Need to work on planned replacement. Currently consumers are dealing with urgent replacement. Need to work with consumers to have planned replacements: provide answers to questions such as what are the options? what are the financing mechanisms? etc.
- Industry need to push for transition and RED needs to include an obligation on companies to incorporate at least a small percentage of energy from RES.

### *Session 3 Sustainability of forest biomass*

*Table 38 - Details of session 3*

| Time | Moderator | Panel |
|---|---|---|
| 15h00 – 16h30 | **Giulio Volpi,** *Policy officer, Decarbonisation and Sustainability of Energy Sources*, DG Energy, European Commission | Keynote interventions<br>• ***Sarah Mubareka,*** Joint Research Centre, European Commission<br>• **Prof. Jean-Pascal van Ypersele,** *former vice-chair of IPCC,* UC Louvain<br>• ***Karoliina Niemi,*** *Forest Director*, Finnish Forest Industries Federation<br>Interventions from attendees<br>• **Kenneth Richter,** *Consultant,* Birdlife Europe<br>• **Alex Mason**, *Senior Policy Officer*, Climate and Energy, WWF European Policy Office<br>• **Simon Armstrong**, *Chief Technical Officer*, Sustainable Biomass Program<br>• **Ulrich Leberle**, *Raw Materials Director*, Confederation of European Paper Industries<br>• **Jean-Marc Jossart**, *Secretary General*, Bioenergy Europe |

*Summary*

The panel started with a presentation by the Joint Research Centre of the European Commission (JRC), on their recent report on woody biomass. According to JRC, the need for a swift and robust implementation of sustainability criteria on forest biomass to minimize biodiversity risks was underlined, along with the reminder that effectiveness will depend on national legislations. The report also identifies risky and positive pathways for producing bioenergy, particularly forest bioenergy, depending on how the raw material is harvested. The two keynote speakers presented on the one hand industry views advocating that current RED II sustainability criteria should not be changed, whereas Prof. Jean-Pascal van Ypersele from UC Louvain reminded that forests were essential for carbon sink and that bioenergy was not carbon neutral as such. A lively debate on the sustainability of bioenergy and carbon neutrality of forest biomass followed, with panellists and attendants sharing different points of view on the role of bioenergy for the 2030 and 2050 targets. Some were against bioenergy being treated as carbon neutral and there was a discussion with regards to the counting (or not) of emissions under LULUCF criteria in REDII. NGOs called for a cap on bioenergy, industry warned against creating regulatory instability which would undermine the achievement of the 2030 targets

*Position of each panellist*

*Sarah Mubareka, Joint Research Centre, European Commission*

- JRC presented on the recent report on woody biomass, available online at https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/use-woody-biomass-energy-production-eu
- Key messages:
  - High dependency on forest-based industries to produce by-products;
  - Overall higher rate for energy demand (increased reported uses of woody biomass for energy & material);
  - Gap in data is a major obstacle
    1. Sustainability criteria covering smaller plants would lead to improved monitoring;
    2. Swiftly implementation for RED II sustainability criteria to avoid negative impacts.
- Extend no go areas (additional safeguard in highly diverse ecosystems).
- Effectiveness of EU measures will depend on national legislation fitness & implementation.

*Prof. Jean-Pascal van Ypersele, former vice-chair of IPCC, UC Louvain*

- Trees are worth more to humanity alive than dead.
- Causal link between $CO_2$ concentration and temperature spirals - urgency to go to net zero emissions of $CO_2$.
  - Limited effect of COVID19 on CO2 emissions
- Provisions from RED II would allow MS to cut and burn trees for energy to the detriment of forests and climate change.
  - Need to stop treating biomass power generation as CO2 neutral, fundamentally revise current consideration of wood burning/wood imports in the EU;
  - Reference to IPCC report and misinterpretation leading to carbon neutrality approach
  - It takes a long time to reabsorb the CO2.
- Significant increase of wood harvesting after 2015 (also shown in paper by Ceccherini et al.) → expansion of wood markets (supported by provisions in RED II).

- Increase in wood pellets due to subsidies.
- EASAC conclusions:
  - CO2 emissions per unit of electricity generated from forest biomass are higher than from coal;
  - Initial impact of replacing coal with forest biomass is increased CO2 levels in the short and medium term;
  - EU (and MS) legislation should ensure only positive contributions to climate change are regarded as RES.
- Payback:
  - The concept of all bioenergy being carbon-neutral is too simplistic. Carbon neutrality involves a payback' period (the time taken for forests to reabsorb the carbon dioxide emitted during biomass combustion), which ranges from decades to hundreds of years.
  - In calculating payback periods, it is essential to properly include the timing of harvesting on carbon stocks as well as supply chain and biogenic emissions. Switching from fossil fuels to forest biomass is the equivalent of taking out a carbon loan.
  - However, although monetary loans require paying back in a specified period, carbon loans currently are free of any such conditions; yet until payback is achieved, the effects on climate are negative.
  - The proximity of current levels of warming to the 1.5C Paris targets requires that only projects whose payback periods are of the order of a decade or less Should be regarded as 'renewable energy'. The distorting effects of the current separation of combustion and Land use and Land- Use and Forestry (LULUCF) emission rules on Climate must be considered.
  - From a mitigation perspective, it is important that forest carbon stocks are maintained — or preferably increased over time.
- Conclusion:
  - Urgency to protect biodiversity/climate;
  - RED wrongly treats wood burning as carbon neutral;
  - This led to increased harvesting of forests and decreased biodiversity;
  - Carbon debt created by burning wood will have to be paid in the future;
  - Separate targets for LULUCF and other sectors without trading between them would be safer (natural sinks are difficult to account for).

*Karoliina Niemi, Forest Director, Finnish Forest Industries Federation*

- Finish Forest Industries Federation (FIFF) – 80 forest companies operating in Finland with global markets;
- Federation lobbies at Finnish, EU, global level;
- Forest resources increasing but unstable. Resources used in products → substitution effect
- Fossils are a one way process → fossil resources are decreasing and are stable;
- Transition from fossil to biobased economy
  - 200bn EUR increase to 2030 for forest industry products;
  - Contribute to green deal & energy solutions.
- Key: Sustainable, active and timely forest management → Keep forests healthy.
- Forestry
  - Produce high quality wood (different by products, resource efficient use of single tree);
  - Manage forest, taking care of biodiversity;
  - Loop system;
  - Different criteria from different EU policy sectors - how to ensure stable operating environment?
- Biomass sustainability

- Focus on eliminating fossil resources and fostering green sustainable solutions
- Sustainability criteria cover all essential parts of biomass sustainability. Reasons against revising them are:
  1. Wood diameter cap does not solve challenge (if any); large diameter trees are burnt if of low quality, due to various issues (diseases, shape, disasters).
  2. Criteria have not been tested yet, as RED II just being implemented.
  3. Risk-based approach is a modern way to assess sustainability of actions, respecting national forestry policy. If legislation is not good enough, then operator can go at sourcing level with certification to proof sustainability.
  4. Industry needs a stable operating environment, and opening criteria would generate years of uncertainty and be a risk for industrial renewal.

*Summary of interventions from attendees*

**Kenneth Richter,** *Consultant,* Birdlife Europe

- NECPs of most MS provide little detail on future biomass sources (and often wrong);
- Danger of steep increase on wood burning for power;
- Burning trees increases net emissions and contributes to forest degradation;
- Feedstock issue, needs feedstock solution (will not be solved with sustainability criteria);
- Only fine forest residue is acceptable, but nobody collects this for power generation;
- Easiest solution is to end support for burning biomass under RED
  - No subsidy for wood harvested from forest, should go to clean energy solutions instead;
  - Can still use waste/residues from forestry activities.

**Alex Mason,** *Senior Policy Officer*, Climate and Energy, WWF European Policy Office

- NGOs are concerned about biodiversity, but main issue with bioenergy rules are the climate issues. If these are fixed, then biodiversity issue will be fixed as well;
- EU policy is encouraging energy that increases emissions compared to fossil energy;
- Key issue is what you are burning (not how it was produced, how the forest was managed);
- Rules are also encouraging dedicated energy crops, food and feed based biogas. Any dedicated use of land will end in more carbon emissions than if the land was left alone;
- There needs to be a feedstock-based approach, and we can expect another U-turn from the EU similarly to what happened with biofuels.

**Simon Armstrong,** *Chief Technical Officer*, Sustainable Biomass Program

- 2/3 of biomass supplied to CHP is supplied via SBP;
- SBP verifies sustainability criteria;
- Effective solution being implemented already through SBP covering large scale of EU biomass energy generation;
- Changing regulation at this stage creates uncertainty, while a consistent approach is necessary;
- Difficult to implement restrictions (such as cm cap), discussed in detail before;
- Practical experience – limitation of stem wood will not be effective:
  - How to differentiate stem wood from branches/leaves;
  - Disproportionate administrative burden;
  - Perverse/unintended outcomes.

**Ulrich Leberle,** *Raw Materials Director*, Confederation of European Paper Industries

- The key concerns related to biomass are:
  - Does it harm forest ecosystem/biodiversity?

- Does it lower CO2 emissions?
- Does it harm the efficient working in the wood sector and forest based economy?

- Last revision struck a balance between env/climate/socio-economic concerns
  - Paper industry thinks that subsidies have distorted markets and shifted the use towards bioenergy.
- LULUCF framework reflects the use of biomass from forest. Other reductions would be needed, so it is not 'neutral'.
- More focus on efficiency, local supply chains, so RED II is showing results already (more sustainable);
- Possibility for MS to exclude technologies based on concerns (following cascading use of materials).

**Jean-Marc Jossart,** *Secretary General*, Bioenergy Europe

- 56% of participants in OPC think RES criteria should not be modified;
- Some participants want to limit feedstock based on an emotional response, but this is a misunderstanding and not an effective way of doing policy
  - Forest owners will never grow a forest for bioenergy, fuelwood is made of discarded wood (colour/shape)
- Strict implementation of RED II is needed;
- LULUCF framework works. We should not count emissions of bioenergy, as this would be a double counting (in line with IPCC/IEA);
- The more wood demand, the more forests will be grown.

*Main topics covered in Session 3*

- Biodiversity protection
- Legislative stability and implementation
- Separate LULUCF targets
- Data gaps for sustainability criteria
- Forest management

*Concluding Remarks by Ditte Juul Jørgensen, Director General, DG ENERGY*

Ditte Juul Jørgensen, Director General DG Energy, concluded the session, by sharing the key takeaways as a summary of the three sessions held during the event. Key points raised concerned:

- The European Commission (EC) needs to accelerate the development of renewable energy in order to achieve the 2050 climate neutrality objective and in order to meet the 2030 targets. This already seen in the Climate Target Plan and the Impact Assessment (in collaboration with DG CLIMA) on how to reach 55% by 2030, which has been agreed upon by all 27 MS. These ambitions translate to a new target of 38-40% renewable energy by 2030, which is significantly higher than the current 32% target.
- *Transport*
  - The EU needs a much higher level of electrification as well the integration of biofuels and hydrogen. To achieve the level of electrification that the EU needs, system integration is crucial.
  - Electrification is the main option to decarbonise road transport, but there are different needs and possibilities for different modes of transport.
  - EC needs to set the right enabling framework for electrification, which requires significant investments, regulatory measures across a range of policy fields.
  - For renewable and low carbon fuels, EC needs to maintain a stable framework, but needs to modify the current framework in order to meet the

objectives. Particularly, hydrogen and hydrogen based synthetic fuels need to be considered for the maritime sector or aviation.
    - The views of stakeholders on the role of biofuels is mixed. EC believes there is a place for the use of advanced biofuels, but the main focus should be electrification.
- *Heating and Cooling*
    - In H&C the level of ambition needs to be stepped up, accompanied with a set of measures to make sure this key sector contributes to the overall ambition. However, there are different aspects that need to be taken account of when setting targets, particularly local specificities/conditions and the criteria around of cost and effectiveness.
    - Price signals are key, including the need to make a level playing field across energy carriers and consistency with carbon pricing.
    - When replacing existing heating systems and looking at what heating systems will be installed, it needs to be ensured that there are no longer investments in fossil based systems.
    - It is important to help make sure there is consumer guidance. Generally, there needs to be a clear framework for consumers to make choices.
    - Buildings need to be reviewed as it is the largest sector for energy use in heating and cooling and largest greenhouse gases emitter. In buildings, there needs to be a level playing field for the different technologies.
    - RED must be coherent and coordinated with the review of the EED and later the EPBD.
    - RED should incentivise investments and remove bureaucratic burdens.
    - District heating and cooling is a feasible and cost effective way to decarbonise heating and cooling in cities and therefore local authorities will play a key role in the DHC systems. The review of RED should support the development of administrative and financial capacity in local authorities and actors, such as communities and local authorities, to implement European and national objectives and increase coordination among the different actors.
    - Waste heat could play a crucial role in integrated energy system and help lower overall consumption and overall GHG emissions. Data centres are a good example of the use of waste heat as a cheap and sustainable heat source.
    - There is a need for a ambitious and higher target for H&C, as compared to current targets, and to increase the rate of renewables in H&C in buildings.
- *Bioenergy and Sustainability*
    - EC needs to make sure that bioenergy policy aligns with biodiversity objectives and the need to establish carbon sinks to help the EU to become climate neutral.
    - Biomass is the main renewable energy source in the EU, it currently contributes to about 10% of the EU's overall energy consumption and 60% of renewable energy consumption. Bioenergy is playing, and will continue to play an important role in decarbonising the energy system. We need to make sure that if bioenergy continues to play this central role in decarbonising the EU economy in the future, it should be done in a sustainable manner to maximise positive impacts of bioenergy, with no negative impacts, that is aligned with biodiversity, afforestation and carbon sinks strategies.
    - In the 2018 RED revisions, the sustainability criteria on bioenergy were strengthened, but they have not yet been implemented
    - Some of possible negative impacts of forest biomass on biodiversity can be avoided with the implementation of the current RED, which will be transposed and implemented in the summer.
    - The JRC report of the use of woody biomass for energy use is part of the overall basis for the review of RED.

- From the JRC report, it is clear that there is a need to include additional no-go areas for forest biomass to minimise the risk that biomass sourcing will have a negative impact on biodiversity
- EC will now look at different options to strengthen sustainability criteria and find a balance between using biomass to decarbonise the EU economy, protect biodiversity and enhancing carbon sinks in order to meet the EU climate ambitions.

- *Current status of the revision of the RED*
  - The European Commission is currently working on the impact assessment of the full Fit for 55 package, which is scheduled for the summer.
  - Since there are close links with RED with the Emission Trading System, the Energy Efficiency Directive and LULUCF regulation, these components are being constructed in a harmonized manner to ensure a consistent and coordinated proposal this summer.

## ANNEX 3: WHO IS AFFECTED AND HOW?

**Member States** could be affected by the procedure to deliver pledges within their national renewables development path, as well as by the provisions for gap-filling instruments in case of difficulties in reaching a higher RES target. The update of National Energy and Climate Plans could require increased consultation and preparation with stakeholders to reach the higher ambition, including for the new subtargets. They would benefit from increased guidance through an enlarged certification scheme and better terminology.

**Local communities** and **municipalities** will also be affected in the effort to coordinate national level and local level renewables planning. This might imply some additional administrative costs for coordination between governmental levels, but also ensure that local authorities are involved from the start so that public resistance issues can be better addressed.

The Revised RES Directive will also impact **non-renewables producers** and **suppliers** with regard to their market share as a consequence of the deployment of more renewables across the EU energy market.

As per **renewables technology producers** and **renewables installers**, the post 2020 renewables and Energy Union Governance policy framework could foster investment security and increase cross border business opportunities.

The **investors** and the **financial sector** will factor in an increased investment security in the post-2020 renewables provisions especically in reducing cost of capital for riskier renewable energy technologies, in particular innovative fuels (RFNBOs, H2).

**Businesses** in general could benefit from the renewables cost reductions expected from new requirements for support to renewables and administrative procedures. Additional certification costs could emerge but would be limited and would be compensated by additional market opportunities.

**Transmissions service operators** and **distribution service operators** could be affected by provisions to enhance energy system integration between DHC systems and other energy networks and eliminate exceptions to make access to networks for renewables and waste heat including from prosumers in large DHC networks. This would enable **energy consumers** to become active market participants.

**Citizens** should be impacted in terms of higher local acceptance of renewables projects and increased utilisation of renewable energy in their energy mix, therefore reaping the ultimate benefit of a lower-carbonisation of the economy at large and related lower degrees of pollution.

SUMMARY OF COSTS AND BENEFITS – based on modelling

| | Benefits | | Costs | | |
|---|---|---|---|---|---|
| Scenarios | MIX vs MIX-LD | Interpretation | MIX vs MIX-CP | Interpretation |

| **2030 EU27 results unless otherwise stated** | **metric** | **MIX** | **MIX-CP** | **MIX-LD** | Difference MIX vs MIX-LD illustrates impact of drivers representing revision of RED working together with other "Fit for 55" proposals | **RED revision brings:** | Difference MIX vs MIX-CP illustrates impact of achieving necessary 2030 RES ambition by drivers representing revision of RED rather than very high carbon pricing | **RED revision compared to very high carbon price brings:** |
|---|---|---|---|---|---|---|---|---|
| GHG reductions (incl intra EU aviation and maritime, excl LULUCF) wrt 1990 | % change from 1990 | 53,1% | 53,0% | 52,1% | 1,0 | 1 p.p. of necessary GHG reduction compared to 1990 | 0,1 | difference is negligible all core scenarios were designed to achieve GHG 55% target |
| Overall RES share | % | 38,0% | 37,6% | 36,3% | 1,7 | 1.7 p.p. bigger share of total RES in final energy consumption in 2030 | 0,3 | Small difference showing that high level of carbon pricing can be as effective as renewables policies in achieving necessary RES shares |
| RES-E share | % | 62,6% | 63,0% | 60,2% | 2,4 | 2.4 p.p. bigger share of RES in electricity in 2030 | -0,4 | Small difference showing that high level of carbon pricing can be as effective as renewables policies in achieving necessary RES shares in electricity |
| RES-H&C share | % | 38,9% | 37,8% | 36,9% | 2,0 | 2 p.p. bigger share of RES in H&C in 2030 | 1,1 | Small difference showing that ambitious regulatory measures are more effective in achieving necessary RES shares in H&C than even very high level of carbon price (€65/t) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RES-T share | % | 26,4% | 26,1% | 25,9% | 0,6 | 0.6 p.p. bigger share of RES in transport in 2030 | 0,4 | Small difference stemming from the fact that level of RES-T ambition is established by ambitious NECPs and initiatives on aviation and maritime fuels |
| PEC energy savings | % change from 2007 Baseline | 38,5% | 38,0% | 37,9% | 0,6 | 0.6 p.p. bigger primary energy savings in 2030 | 0,5 | Small difference illustrating that higher RES-E shares have positive impact on PEC |
| FEC energy savings | % change from 2007 Baseline | 35,8% | 34,9% | 35,3% | 0,5 | 0.5 p.p. bigger final energy savings in 2030 | 0,8 | Small difference illustrating that higher RES-H&C shares have positive impact on FEC |
| Investment expenditures (excl transport) av annual (2021-30) | bn €'15/year | 410 | 393 | 396 | 13 | Average annual investment needs higher by € 13bn | 17 | Average annual investment needs higher by € 17 bn compared to case with high carbon price as main driver |
| Energy system costs excl carbon pricing and disutilities av annual (2021-30) | bn €'15/year | 1543 | 1535 | 1539 | 4 | Average annual system costs higher by € 4bn | 8 | Average annual system costs higher by € 4bn compared to case with high carbon price as main driver |
| ETS price in current sectors (and maritime) | €/tCO2 | 46 | 51 | 46 | 0 | no significant change - level of carbon price was frozen between MIX and MIX-LD | -5 | Carbon price can by lower by 5€/t in the current ETS sectors |
| ETS price in new sectors (buildings and road transport) | €/tCO3 | 46 | 68 | 46 | 0 | no significant change - level of carbon price was frozen between MIX and MIX-LD | -23 | Carbon price can by lower by 23€/t in the new ETS sectors |
| Average Price of Electricity | €/MWh | 166 | 167 | 165 | 1 | no significant change | -1 | no significant change |
| Import dependency | % | 53% | 53% | 53% | 0 | no significant change | 0 | no significant change |
| Fossil fuels imports bill savings compared to BSL for the period 2021-30) | bn €'15 | 91 | 79 | 75 | 16 | Savings on fossil fuels import bill are higher by 16 bn | 12 | Savings on fossil fuels import bill are higher by 12 bn |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Energy-related expenditures (excl transport) of households as % of households income | % | 7,8% | 7,7% | 7,7% | 0,1 | no significant change | 0,1 | no significant change |

SUMMARY OF BENEFITS

As observed in the CTP impact assessment, an increased climate target for 2030, and the subsequent actions undertaken as regards renewable energy, will require considerable additional investments. At the same time the main benefit of the options is that they are an effective way for the Member States to collectively increase the use of renewable energy, thus contributing to the aim to reduce GHG emissions by 55% by 2030.

A more secure EU energy system, less dependent on imports, would be achieved by the increase in renewable energy, in particular from offshore. Air quality in cities will be improved by among others renewable heating, especially district heating in cities, and increased use of RES in transport, as well as electrification of transport. Many of the policy options are projected to create jobs, in line with the envisaged green digital recovery. Fuel suppliers will be positively impacted by the expansion of the EU system for certification of renewable and low carbon fuels as it will make it easier for them to sell to consumers who need to show sourcing of renewable energy. Positive biodiversity impacts will follow from stronger sustainability criteria for bioenergy. It may reduce import from outside the EU of biomass fuels, as third countries choose not to comply with them and redirect their export away from the EU. This would have a positive effect on the internal supply, allowing EU producers (farmers and forest owners) to obtain higher prices.

Overall the policy options have positive economic, environmental and societal benefits.

SUMMARY OF ADMINISTRATIVE AND COMPLIANCE COSTS:

For Member States:

- Regarding revised renewable energy target, the administrative costs can be estimated to be low or even close to zero as these targets can be monitored through official statistics (renewable energy shares including sectoral and absolute amounts per technology) which are already readily available at national level and from Eurostat;

- Regarding the target for H&C no additional administrative burden or increased compliance costs are expected as no new obligations or additional reporting would be required from the Member States compared to the current Article 23 of RED II or the Governance framework;

- Regarding the measures for H&C this depends on the member States choice of the measures to be implemented;

- Regarding the revised transport target, the preferred option would reduce the administrative burden for public authorities compared to the baseline as all options would eliminate the current overlaps between the FQD and REDII;

- Regarding the indicative target benchmark for renewables in buildings, this option could lead to is unlikely to lead to an increase in administrative burden depending on the measures a Member State choses to use to reach the target. On the other hand as Member States are already obliged to design such measures as part of their long-term renovation strategies, required under Article 2a of the EPBD, and which formed part of the NECPs submitted in 2019, so such measures should already be known and in place. Increased compliance costs are therefore not foreseen;

- Regarding the target for renewables in industry, considering that general statistics on energy consumption in industrial sectors already take place as part of the EU energy balances, the impact on any administrative burden will be limited;

- Regarding the strengthened sustainability criteria for biomass, National authorities are likely to face moderately increased administrative burden associated with the monitoring of the new no-go areas.

For Industry:

- Compliance costs for industry to get these have renewable and low carbon fuels certified can occur but it can be expected that they will be largely compensated by the market opportunities, which the certification and respective labelling would provide to them;

- Regarding the strengthened sustainability criteria for biomass, the preferred option is likely to moderately increase the administrative burden and compliance costs for economic operators. Costs for bioenergy operators may increase because of additional administrative costs to demonstrate compliance with new land criteria. Fuel cost for biomass plants owners may also increase, due to producers passing the additional costs and, to some extent, reduced supply (introduction of no-go areas is likely to impact mainly biomass imports).

For households:

- Equipment costs, Renovation costs, Disutility costs, Energy expenses related to buildings as share of households total consumption,

A summary of the administrative and compliance related costs of the revision are presented below:

| ***Description*** | ***Expected additional administrative and compliance related costs*** | ***Comments*** |
|---|---|---|
| Higher overall EU renewable energy target | Low/zero | These targets already exist so no new administrative costs and they can be monitored through official statistics (renewable energy shares including sectoral and absolute amounts per technology) which are already readily available at |

| | | |
|---|---|---|
| | | national level and from Eurostat albeit legal basis for MS work on this reporting is missing. This should be addressed in revision but as all MS already deliver the necessary reporting in the current framework, no additional reporting framework needs to be added. On the other hand, the reporting will have to be deepened (RFNBOs, e-fuels); |
| Renewable energy target for heating and cooling | Low/zero | Target already exists so no new administrative/monitoring costs.<br><br>The policy measures depends on the choice by Member States |
| Renewable energy target for transport | Low | Overlaps between FQD and REDII should be eliminated, leading to greater efficiency and lower costs for administrations. |
| Benchmark for renewable energy in buildings | Low | Member States are already obliged to monitor and report on RES in H&C of buildings but not at such level of detail as new benchmark would require. |
| Target for renewable energy for industry | Low | Member States are already obliged to monitor and report on RES in H&C of industry but not at such level of detail as new target would require.<br>Including RES in energy audits may increase the costs of audits, but would be compensated by the savings potentials identified. |
| Accounting and certification of e-fuels/RFNBOs | Medium | Some increase in costs to have all renewable and low carbon fuels accounted for and certified. |
| Strengthened sustainability criteria for biomass, | Medium | Moderately increased administrative and compliance costs for economic operators associated with monitoring. Possible rise in fuel costs for biomass plants owners |

## ANNEX 4: ANALYTICAL METHODS

### 4.1 Common analytical framework for the Impact Assessments of the revision of ESR, ETS, $CO_2$ standards, LULUCF, RED and EED

#### *4.1.1 Introduction*

Aiming at covering the entire GHG emissions from the EU economy, and combining horizontal and sectoral instruments, the various pieces of legislation under the "Fit for 55" package strongly interlink, either because they cover common economic sectors (e.g. buildings sector is currently addressed by energy efficiency and renewable polices but would be also falling in the scope of extended ETS) or by the direct and indirect interactions between these sectors (e.g. electricity supply sector and final demand sectors using electricity).

As a consequence, it is crucial to ensure consistency of the analysis across all initiatives. For this purpose, the impact assessments underpinning the "Fit for 55" policy package are using a collection of integrated modelling tools covering the entire GHG emissions of the EU economy.

These tools are used to produce a common Baseline and a set of core scenarios reflecting internally coherent policy packages aligned with the revised 2030 climate target, key policy findings of the CTP and building on the Reference Scenario 2020, a projection of the evolution of EU and national energy systems and GHG emissions under the current policy framework[8]. These core scenarios serve as a common analytical basis for use across different "Fit for 55" policy initiatives, and are complemented by specific variants as well as additional tools and analyses relevant for the different initiatives.

This Annex describes the tools used to produce the common baseline (the Reference Scenario 2020) and the core policy scenarios, the key assumptions underpinning the analysis, and the policy packages reflected in the core policy scenarios.

#### *4.1.2 Modelling tools for assessments of policies*

Main modelling suite

The main model suite used to produce the scenarios presented in this impact assessment has a successful record of use in the Commission's energy, transport and climate policy assessments. In particular, it has been used for the Commission's proposals for the Climate Target Plan[9] to analyse the increased 2030 mitigation target, the Sustainable and Smart Mobility Strategy[10], the Long Term Strategy[11] as well as for the 2020 and 2030 EU's climate and energy policy framework.

The PRIMES and PRIMES-TREMOVE models are the core elements of the modelling framework for energy, transport and $CO_2$ emission projections. The GAINS model is used for non-$CO_2$ greenhouse gas emission projections, the GLOBIOM-G4M models for

[8] The "current policy framework" includes EU initiatives adopted as of end of 2019 and the national objectives and policies and measures as set out in the final National Energy and Climate Plans – see the EU Reference Scenario 2020 publication.
[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176
[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331
[11] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

projections of LULUCF emissions and removals and the CAPRI model is used for agricultural activity projections.

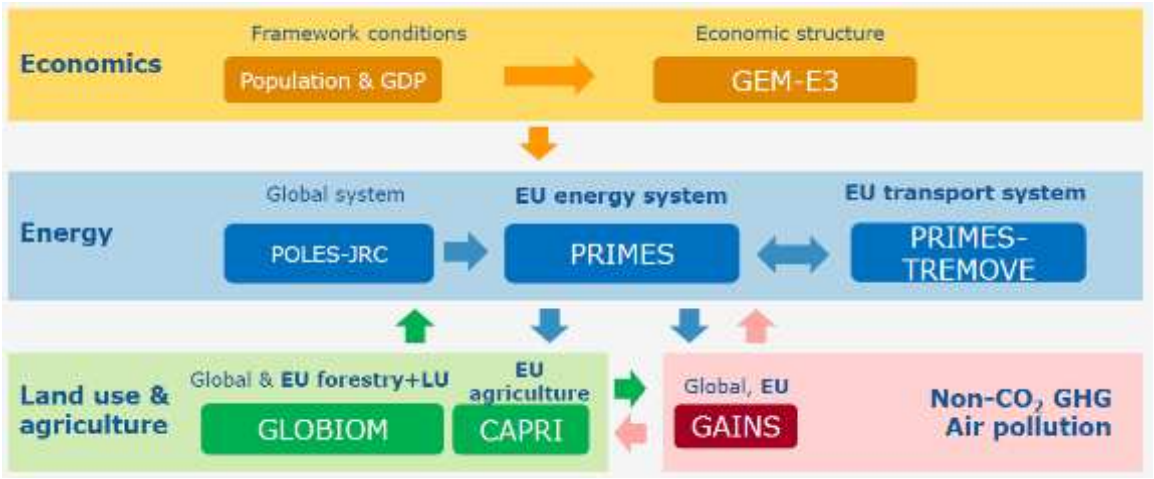
The model suite thus covers:

- **The entire energy system** (energy demand, supply, prices and investments to the future) and **all GHG emissions and removals** from the EU economy.
- **Time horizon:** 1990 to 2070 (5-year time steps).
- **Geography:** individually all EU Member States, EU candidate countries and, where relevant the United Kingdom, Norway, Switzerland and Bosnia and Herzegovina.
- **Impacts:** energy system (PRIMES and its satellite model on biomass), transport (PRIMES-TREMOVE), agriculture, waste and other non-$CO_2$ emissions (GAINS), forestry and land use (GLOBIOM-G4M), atmospheric dispersion, health and ecosystems (acidification, eutrophication) (GAINS).

The modelling suite has been continuously updated over the past decade. Updates include the addition of a new buildings module in PRIMES, improved representation of the electricity sector, more granular representation of hydrogen (including cross-border trade[12]) and other innovative fuels, improved representation of the maritime transport sector, as well updated interlinkages of the models to improve land use and non-$CO_2$ modelling. Most recently a major update was done of the policy assumptions, technology costs and macro-economic assumptions in the context of the Reference scenario 2020 update.

The models are linked with each other in such a way to ensure consistency in the building of scenarios (see figure below). These inter-linkages are necessary to provide the core of the analysis, which are interdependent energy, transport and GHG emissions trends.

*Figure 69 - Interlinkages between models*




[12] While cross-border trade is possible, the assumption is that there are no imports from outside EU as the opposite would require global modelling of hydrogen trade.

Energy: the PRIMES model

The PRIMES model (Price-Induced Market Equilibrium System)[13] is a large scale applied energy system model that provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energy system including emissions. The distinctive feature of PRIMES is the combination of behavioural modelling (following a micro-economic foundation) with engineering aspects, covering all energy sectors and markets.

The model has a detailed representation of policy instruments related to energy markets and climate, including market drivers, standards, and targets by sector or overall. It simulates the EU Emissions Trading System. It handles multiple policy objectives, such as GHG emissions reductions, energy efficiency, and renewable energy targets, and provides pan-European simulation of internal markets for electricity and gas.

The model covers the horizon up to 2070 in 5-year interval periods and includes all Member States of the EU individually, as well as neighbouring and candidate countries.

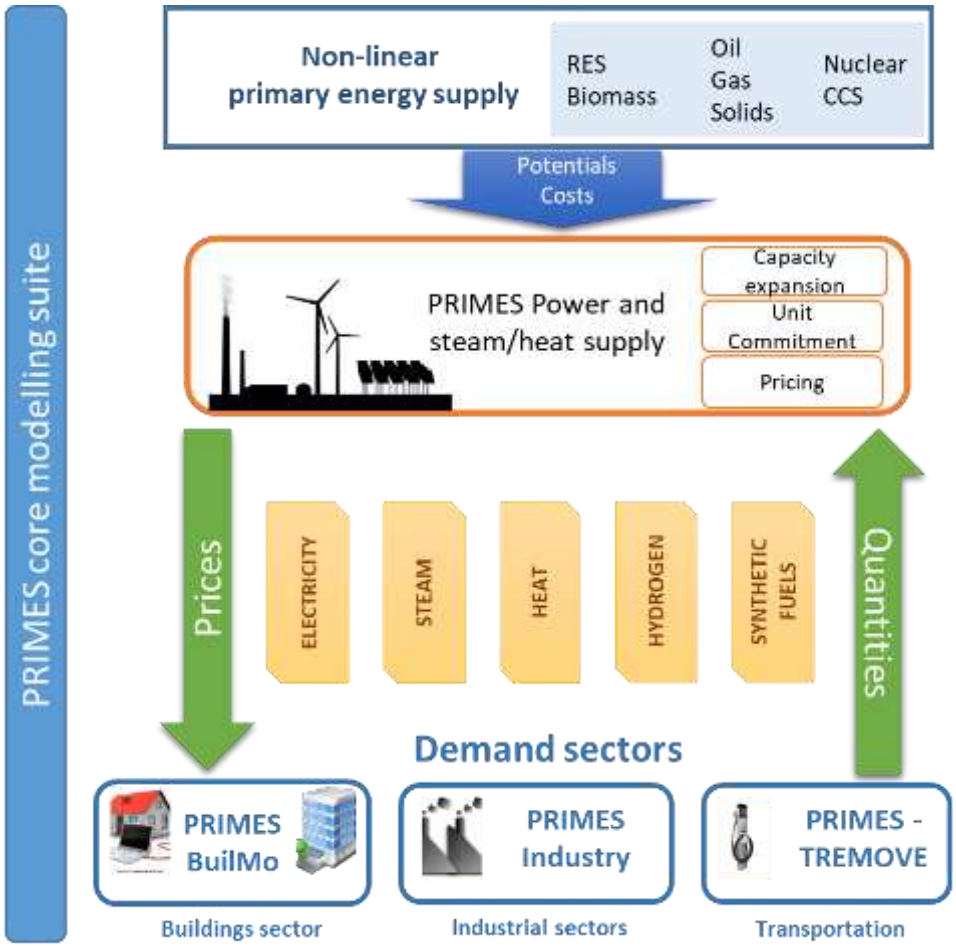
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

PRIMES is designed to analyse complex interactions within the energy system in a multiple agent – multiple markets framework. Decisions by agents are formulated based on microeconomic foundation (utility maximization, cost minimization and market equilibrium) embedding engineering constraints and explicit representation of technologies and vintages, thus allowing for foresight for the modelling of investment in all sectors.

PRIMES allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning. The figure below shows a schematic representation of the PRIMES model.

[13] More information and model documentation: https://e3modelling.com/modelling-tools/primes/

*Figure 70: Schematic representation of the PRIMES model*




It includes a detailed numerical model on biomass supply, namely PRIMES-Biomass, which simulates the economics of current and future supply of biomass and waste for energy purposes. The model calculates the inputs in terms of primary feedstock of biomass and waste to satisfy a given demand for bio-energy and provides quantification of the required capacity to transform feedstock into bioenergy commodities. The resulting production costs and prices are quantified. The PRIMES-Biomass model is a key link of communication between the energy system projections obtained by the core PRIMES energy system model and the projections on agriculture, forestry and non-$CO_2$ emissions provided by other modelling tools participating in the scenario modelling suite (CAPRI, GLOBIOM/G4M, GAINS).

It also includes a simple module which projects industrial process GHG emissions.

PRIMES is a private model maintained by E3Modelling[14], originally developed in the context of a series of research programmes co-financed by the European Commission. The model has been successfully peer-reviewed, last in 2011[15]; team members regularly participate in international conferences and publish in scientific peer-reviewed journals.

[14] E3Modelling (https://e3modelling.com/) is a private consulting, established as a spin-off inheriting staff, knowledge and software-modelling innovation of the laboratory E3MLab from the National Technical University of Athens (NTUA).
[15] SEC(2011)1569 : https://ec.europa.eu/energy/sites/ener/files/documents/sec_2011_1569_2.pdf

*Sources for data inputs*

A summary of database sources, in the current version of PRIMES, is provided below:

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and projections, physical activity data (complemented by other sources), CHP surveys, $CO_2$ emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS
- Technology databases: ODYSSEE-MURE[16], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[17], IPPC BAT Technologies[18]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[19], JRC EMHIRES[20], RES ninja[21], ECN, DLR and Observer, IRENA
- Network infrastructure: ENTSOE, GIE, other operators
- Other databases: EU GHG inventories, district heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project[22], INSPIRE archive, BPIE[23]), JRC-IDEES[24], update to the EU Building stock Observatory[25]

Transport: the PRIMES-TREMOVE model

The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport, by transport mode, and transport vehicle/technology, following a formulation based on microeconomic foundation of decisions of multiple actors. Operation, investment and emission costs, various policy measures, utility factors and congestion are among the drivers that influence the projections of the model. The projections of activity, equipment (fleet), usage of equipment, energy consumption and emissions (and other externalities) constitute the set of model outputs.

The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

In the transport field, PRIMES-TREMOVE is suitable for modelling *soft measures* (e.g. eco-driving, labelling); *economic measures* (e.g. subsidies and taxes on fuels, vehicles, emissions; ETS for transport when linked with PRIMES; pricing of congestion and other externalities such as air pollution, accidents and noise; measures supporting R&D); *regulatory measures* (e.g. $CO_2$ emission performance standards for new light duty

[16] https://www.odyssee-mure.eu/
[17] Source: https://www.eia.gov/outlooks/aeo/info_nems_archive.php
[18] Source: https://eippcb.jrc.ec.europa.eu/reference/
[19] Source: https://data.jrc.ec.europa.eu/collection/id-00138
[20] Source: https://data.jrc.ec.europa.eu/dataset/jrc-emhires-wind-generation-time-series
[21] Source: https://www.renewables.ninja/
[22] Source: https://www.entranze.eu/
[23] Source: http://bpie.eu/
[24] Source: https://ec.europa.eu/jrc/en/potencia/jrc-idees
[25] Source: https://ec.europa.eu/energy/en/eubuildings

vehicles and heavy duty vehicles; EURO standards on road transport vehicles; technology standards for non-road transport technologies, deployment of Intelligent Transport Systems) and *infrastructure policies for alternative fuels* (e.g. deployment of refuelling/recharging infrastructure for electricity, hydrogen, LNG, CNG). Used as a module that contributes to the PRIMES model energy system model, PRIMES-TREMOVE can show how policies and trends in the field of transport contribute to economy-wide trends in energy use and emissions. Using data disaggregated per Member State, the model can show differentiated trends across Member States.

The PRIMES-TREMOVE has been developed and is maintained by E3Modelling, based on, but extending features of, the open source TREMOVE model developed by the TREMOVE[26] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[27] Other parts, like the component on fuel consumption and emissions, follow the COPERT model.

*Data inputs*

The main data sources for inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[28]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

In the context of this exercise, the PRIMES-TREMOVE transport model is calibrated to 2005, 2010 and 2015 historical data. Available data on 2020 market shares of different powertrain types have also been taken into account.

Maritime transport: PRIMES-maritime model

The maritime transport model is a specific sub-module of the PRIMES and PRIMES-TREMOVE models aiming to enhance the representation of the maritime sector within the energy-economy-environment modelling nexus. The model, which can run in stand-alone and/or linked mode with PRIMES and PRIMES-TREMOVE, produces long-term energy and emission projections, until 2070, separately for each EU Member-State.

The coverage of the model includes the European intra-EU maritime sector as well as the extra-EU maritime shipping. The model covers both freight and passenger international maritime. PRIMES-maritime focuses only on the EU Member State, therefore trade activity between non-EU countries is outside the scope of the model. The model considers the transactions (bilateral trade by product type) of the EU-Member States with non-EU countries and aggregates these countries in regions. Several types and sizes of vessels are considered.

[26] Source: https://www.tmleuven.be/en/navigation/TREMOVE

[27] Several model enhancements were made compared to the standard TREMOVE model, as for example: for the number of vintages (allowing representation of the choice of second-hand cars); for the technology categories which include vehicle types using electricity from the grid and fuel cells. The model also incorporates additional fuel types, such as biofuels (when they differ from standard fossil fuel technologies), LPG, LNG, hydrogen and e-fuels. In addition, representation of infrastructure for refuelling and recharging are among the model refinements, influencing fuel choices. A major model enhancement concerns the inclusion of heterogeneity in the distance of stylised trips; the model considers that the trip distances follow a distribution function with different distances and frequencies. The inclusion of heterogeneity was found to be of significant influence in the choice of vehicle-fuels especially for vehicles-fuels with range limitations.

[28] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en

PRIMES-maritime features a modular approach based on the demand and the supply modules. The demand module projects maritime activity for each EU Member State by type of cargo and by corresponding partner. Econometric functions correlate demand for maritime transport services with economic indicators considered as demand drivers, including GDP, trade of energy commodities (oil, coal, LNG), trade of non-energy commodities, international fuel prices, etc. The supply module simulates a representative operator controlling the EU fleet, who offers the requested maritime transport services. The operator of the fleet decides the allocation of the vessels activity to the various markets (representing the different EU MS) where different regulatory regimes may apply (e.g. environmental zones). The fleet of vessels disaggregated into several categories is specific to cargo types. PRIMES maritime utilizes a stock-flow relationship to simulate the evolution of the fleet of vessels throughout the projection period and the purchasing of new vessels.

PRIMES-maritime solves a virtual market equilibrium problem, where demand and supply interact dynamically in each consecutive time period, influenced by a variety of exogenous policy variables, notably fuel standards, pricing signals (e.g. ETS), environmental and efficiency/operational regulations and others. The PRIMES maritime model projects energy consumption by fuel type and purpose as well as $CO_2$, methane and $N_2O$ and other pollutant emissions. The model includes projections of costs, such as capital, fuel, operation costs, projections of investment expenditures in new vessels and negative externalities from air pollution.

The model serves to quantify policy scenarios supporting the transition towards carbon neutrality. It considers the handling of a variety of fuels such as fossil fuels, biofuels (bioheavy[29], biodiesel, bio-LNG), synthetic fuels (synthetic diesel, fuel oil and gas, e-ammonia and e-methanol) produced from renewable electricity, hydrogen produced from renewable electricity (for direct use and for use in fuel cell vessels) and electricity for electric vessels. Well-to-Wake emissions are calculated thanks to the linkage with the PRIMES energy systems model which derives ways of producing such fuels. The model also allows to explore synergies with Onshore Power Supply systems. Environmental regulation, fuel blending mandates, GHG emission reduction targets, pricing signals and policies increasing the availability of fuel supply and supporting the alternative fuel infrastructure are identified as drivers, along fuel costs, for the penetration of new fuels. As the model is dynamic and handles vessel vintages, capital turnover is explicit in the model influencing the pace of fuel and vessel substitution.

Data inputs

The main data sources for inputs to the PRIMES-maritime model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[30]. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports. PRIMES-maritime being part of the overall PRIMES model is it calibrated to the EUROSTAT energy balances and transport activity; hence the associated $CO_2$ emissions are assumed to derive from the combustion of these fuel quantities. The model has been adapted to reflect allocation of $CO_2$ emissions into intra-EU, extra-EU and berth, in line with data from the MRV database.[31] For air pollutants, the model draws on the EEA database.

[29] Bioheavy refers to bio heavy fuel oil.
[30] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en
[31] https://mrv.emsa.europa.eu/#public/eumrv

In the context of this exercise, the PRIMES-maritime model is calibrated to 2005, 2010 and 2015 historical data.

Non-$CO_2$ GHG emissions and air pollution: GAINS

The GAINS (Greenhouse gas and Air Pollution Information and Simulation) model is an integrated assessment model of air pollutant and greenhouse gas emissions and their interactions. GAINS brings together data on economic development, the structure, control potential and costs of emission sources and the formation and dispersion of pollutants in the atmosphere.

In addition to the projection and mitigation of non-$CO_2$ greenhouse gas emissions at detailed sub-sectorial level, GAINS assesses air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

Model uses include the projection of non-$CO_2$ GHG emissions and air pollutant emissions for the EU Reference scenario and policy scenarios, calibrated to UNFCCC emission data as historical data source. This allows for an assessment, per Member State, of the (technical) options and emission potential for non-$CO_2$ emissions. Health and environmental co-benefits of climate and energy policies such as energy efficiency can also be assessed.

The GAINS model is accessible for expert users through a model interface[32] and has been developed and is maintained by the International Institute of Applied Systems Analysis[33]. The underlying algorithms are described in publicly available literature. GAINS and its predecessor RAINS have been peer reviewed multiple times, in 2004, 2009 and 2011.

*Sources for data inputs*

The GAINS model assesses emissions to air for given externally produced activity data scenarios. For Europe, GAINS uses macroeconomic and energy sector scenarios from the PRIMES model, for agricultural sector activity data GAINS adopts historical data from EUROSTAT and aligns these with future projections from the CAPRI model. Projections for waste generation, organic content of wastewater and consumption of F-gases are projected in GAINS in consistency with macroeconomic and population scenarios from PRIMES. For global scenarios, GAINS uses macroeconomic and energy sector projections from IEA World Energy Outlook scenarios and agricultural sector projections from FAO. All other input data to GAINS, i.e., sector- and technology- specific emission factors and cost parameters, are taken from literature and referenced in the documentation.

Forestry and land-use: GLOBIOM-G4M

The Global Biosphere Management Model (GLOBIOM) is a global recursive dynamic partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with the aim to provide policy analysis on global issues concerning land use competition between the major land-based production sectors. Agricultural and forestry production as

[32] Source: http://gains.iiasa.ac.at/models/
[33] Source: http://www.iiasa.ac.at/

well as bioenergy production are modelled in a detailed way accounting for about 20 globally most important crops, a range of livestock production activities, forestry commodities as well as different energy transformation pathways.

GLOBIOM covers 50 world regions / countries, including the EU27 Member States.

Model uses include the projection of emissions from land use, land use change and forestry (LULUCF) for EU Reference scenario and policy scenarios. For the forestry sector, emissions and removals are projected by the Global Forestry Model (G4M), a geographically explicit agent-based model that assesses afforestation, deforestation and forest management decisions. GLOBIOM-G4M is also used in the LULUCF impact assessment to assess the options (afforestation, deforestation, forest management, and cropland and grassland management) and costs of enhancing the LULUCF sink for each Member State.

The GLOBIOM-G4M has been developed and is maintained by the International Institute of Applied Systems Analysis[34].

*Sources for data inputs*

The main market data sources for GLOBIOM-EU are EUROSTAT and FAOSTAT, which provide data at the national level and which are spatially allocated using data from the SPAM model[35]. Crop management systems are parameterised based on simulations from the biophysical process-based crop model EPIC. The livestock production system parameterization relies on the dataset by Herrero et al[36]. Further datasets are incorporated, coming from the scientific literature and other research projects.

GLOBIOM is calibrated to FAOSTAT data for the year 2000 (average 1998 - 2002) and runs recursively dynamic in 10-year time-steps. In the context of this exercise, baseline trends of agricultural commodities are aligned with FAOSTAT data for 2010/2020 and broadly with AGLINK-COSIMO trends for main agricultural commodities in the EU until 2030.

The main data sources for G4M are CORINE, Forest Europe (MCPFE, 2015)[37], countries' submissions to UNFCCC and KP, FAO Forest Resource Assessments, and national forest inventory reports. Afforestation and deforestation trends in G4M are calibrated to historical data for the period 2000-2013.

Agriculture: CAPRI

CAPRI is a global multi-country agricultural sector model, supporting decision making related to the Common Agricultural Policy and environmental policy and therefore with far greater detail for Europe than for other world regions. It is maintained and developed in a network of public and private agencies including the European Commission (JRC), Universities (Bonn University, Swedish University of Agricultural Sciences, Universidad Politécnica de Madrid), research agencies (Thünen Institute), and private agencies

[34] Source : http://www.iiasa.ac.at/

[35] See You, L., Wood, S. (2006). An Entropy Approach to Spatial Disaggregation of Agricultural Production, Agricultural Systems 90, 329–47 and http://mapspam.info/ .

[36] Herrero, M., Havlík, P., et al. (2013). Biomass Use, Production, Feed Efficiencies, and Greenhouse Gas Emissions from Global Livestock Systems, Proceedings of the National Academy of Sciences 110, 20888–93.

[37] MCPFE (2015). Forest Europe, 2015: State of Europe's Forests 2015. Madrid, Ministerial Conference on the Protection of Forests in Europe: 314.

(EuroCARE), in charge for use in this modelling cluster). The model takes inputs from GEM-E3, PRIMES and PRIMES Biomass model, provides outputs to GAINS, and exchanges information with GLOBIOM on livestock, crops, and forestry as well as LULUCF effects.

The CAPRI model provides the agricultural outlook for the Reference Scenario, in particular on livestock and fertilisers use, further it provides the impacts on the agricultural sector from changed biofuel demand. It takes into account recent data and builds on the 2020 EU Agricultural Outlook[38]. Depending on the need it may also be used to run climate mitigation scenarios, diet shift scenarios or CAP scenarios.

Cross checks are undertaken ex-ante and ex-post to ensure consistency with GLOBIOM on overlapping variables, in particular for the crop sector.

*Sources for data inputs*

The main data source for CAPRI is EUROSTAT. This concerns data on production, market balances, land use, animal herds, prices, and sectoral income. EUROSTAT data are complemented with sources for specific topics (like CAP payments or biofuel production). For Western Balkan regions a database matching with the EUROSTAT inputs for CAPRI has been compiled based on national data. For non-European regions the key data source is FAOSTAT, which also serves as a fall back option in case of missing EUROSTAT data. The database compilation is a modelling exercise on its own because usually several sources are available for the same or related items and their reconciliation involves the optimisation to reproduce the hard data as good as possible while maintaining all technical constraints like adding up conditions.

In the context of this exercise, the CAPRI model uses historical data series at least up to 2017, and the first simulation years (2010 and 2015) are calibrated on historical data.

### *4.1.3 Assumptions on technology, economics and energy prices*

In order to reflect the fundamental socio-economic, technological and policy developments, the Commission prepares periodically an EU Reference Scenario on energy, transport and GHG emissions. The scenarios assessment used for the "Fit for 55" policy package builds on the latest "EU Reference Scenario 2020" (REF2020)[39].

The main assumptions related to economic development, international energy prices and technologies are described below.

Economic assumptions

The modelling work is based on socio-economic assumptions describing the expected evolution of the European society. Long-term projections on population dynamics and economic activity form part of the input to the energy model and are used to estimate final energy demand.

Population projections from Eurostat[40] are used to estimate the evolution of the European population, which is expected to change little in total number in the coming decades. The

[38] EU Agricultural Outlook for markets, income and environment 2020-2030, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2020-report_en.pdf
[39] See related publication.
[40] EUROPOP2019 population projections

GDP growth projections are from the Ageing Report 2021[41] by the Directorate General for Economic and Financial Affairs, which are based on the same population growth assumptions.

Table 39. Projected population and GDP growth per MS

| | Population | | | GDP growth | |
|---|---|---|---|---|---|
| | 2020 | 2025 | 2030 | 2020-'25 | 2026-'30 |
| EU27 | 447.7 | 449.3 | 449.1 | 0.9% | 1.1% |
| Austria | 8.90 | 9.03 | 9.15 | 0.9% | 1.2% |
| Belgium | 11.51 | 11.66 | 11.76 | 0.8% | 0.8% |
| Bulgaria | 6.95 | 6.69 | 6.45 | 0.7% | 1.3% |
| Croatia | 4.06 | 3.94 | 3.83 | 0.2% | 0.6% |
| Cyprus | 0.89 | 0.93 | 0.96 | 0.7% | 1.7% |
| Czechia | 10.69 | 10.79 | 10.76 | 1.6% | 2.0% |
| Denmark | 5.81 | 5.88 | 5.96 | 2.0% | 1.7% |
| Estonia | 1.33 | 1.32 | 1.31 | 2.2% | 2.6% |
| Finland | 5.53 | 5.54 | 5.52 | 0.6% | 1.2% |
| France | 67.20 | 68.04 | 68.75 | 0.7% | 1.0% |
| Germany | 83.14 | 83.48 | 83.45 | 0.8% | 0.7% |
| Greece | 10.70 | 10.51 | 10.30 | 0.7% | 0.6% |
| Hungary | 9.77 | 9.70 | 9.62 | 1.8% | 2.6% |
| Ireland | 4.97 | 5.27 | 5.50 | 2.0% | 1.7% |
| Italy | 60.29 | 60.09 | 59.94 | 0.3% | 0.3% |
| Latvia | 1.91 | 1.82 | 1.71 | 1.4% | 1.9% |
| Lithuania | 2.79 | 2.71 | 2.58 | 1.7% | 1.5% |
| Luxembourg | 0.63 | 0.66 | 0.69 | 1.7% | 2.0% |
| Malta | 0.51 | 0.56 | 0.59 | 2.7% | 4.1% |
| Netherlands | 17.40 | 17.75 | 17.97 | 0.7% | 0.7% |
| Poland | 37.94 | 37.57 | 37.02 | 2.1% | 2.4% |
| Portugal | 10.29 | 10.22 | 10.09 | 0.8% | 0.8% |
| Romania | 19.28 | 18.51 | 17.81 | 2.7% | 3.0% |
| Slovakia | 5.46 | 5.47 | 5.44 | 1.1% | 1.7% |
| Slovenia | 2.10 | 2.11 | 2.11 | 2.1% | 2.4% |
| Spain | 47.32 | 48.31 | 48.75 | 0.9% | 1.6% |

https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data

[41] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

| | | | | | |
|---|---|---|---|---|---|
| Sweden | 10.32 | 10.75 | 11.10 | 1.4% | 2.2% |

Beyond the update of the population and growth assumptions, an update of the projections on the sectoral composition of GDP was also carried out using the GEM-E3 computable general equilibrium model. These projections take into account the potential medium- to long-term impacts of the COVID-19 crisis on the structure of the economy, even though there are inherent uncertainties related to its eventual impacts. Overall, conservative assumptions were made regarding the medium-term impacts of the pandemic on the re-localisation of global value chains, teleworking and teleconferencing and global tourism.

International energy prices assumptions

Alongside socio-economic projections, EU energy modelling requires projections of international fuel prices. The 2020 values are estimated from information available by mid-2020. The projections of the POLES-JRC model – elaborated by the Joint Research Centre and derived from the Global Energy and Climate Outlook (GECO[42]) – are used to obtain long-term estimates of the international fuel prices.

The COVID crisis has had a major impact on international fuel prices[43]. The lost demand cause an oversupply leading to decreasing prices. The effect on prices compared to pre-COVID estimates is expected to be still felt up to 2030. Actual development will depend on the recovery of global oil demand as well as supply side policies[44].

The table below shows the international fuel prices assumptions of the REF2020 and of the different scenarios and variants used in the "Fit for 55" policy package impact assessments.

*Table 40: International fuel prices assumptions*

| in $'15 per boe | 2000 | '05 | '10 | '15 | '20 | '25 | '30 | '35 | '40 | '45 | '50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil | 38.4 | 65.4 | 86.7 | 52.3 | 39.8 | 59.9 | 80.1 | 90.4 | 97.4 | 105.6 | 117.9 |
| Gas (NCV) | 26.5 | 35.8 | 45.8 | 43.7 | 20.1 | 30.5 | 40.9 | 44.9 | 52.6 | 57.0 | 57.8 |
| Coal | 11.2 | 16.9 | 23.2 | 13.1 | 9.5 | 13.6 | 17.6 | 19.1 | 20.3 | 21.3 | 22.3 |
| | | | | | | | | | | | |
| in €'15 per boe | 2000 | 2005 | '10 | '15 | '20 | '25 | '30 | '35 | '40 | '45 | '50 |
| Oil | 34.6 | 58.9 | 78.2 | 47.2 | 35.8 | 54.0 | 72.2 | 81.5 | 87.8 | 95.2 | 106.3 |
| Gas (NCV) | 23.4 | 31.7 | 40.6 | 38.7 | 17.8 | 27.0 | 36.2 | 39.7 | 46.6 | 50.5 | 51.2 |
| Coal | 9.9 | 15.0 | 20.6 | 11.6 | 8.4 | 12.0 | 15.6 | 16.9 | 18.0 | 18.9 | 19.7 |

*Source: Derived from JRC, POLES-JRC model, Global Energy and Climate Outlook (GECO)*

Technology assumptions

Modelling scenarios on the evolution of the energy system is highly dependent on the assumptions on the development of technologies - both in terms of performance and costs. For the purpose of the impact assessments related to the "Climate Target Plan" and

[42] https://ec.europa.eu/jrc/en/geco
[43] IEA, Global Energy Review 2020, June 2020
[44] IEA, Oil Market Report, June 2020 and US EIA, July 2020.

the "Fit for 55" policy package, these assumptions have been updated based on a rigorous literature review carried out by external consultants in collaboration with the JRC[45].

Continuing the approach adopted in the long-term strategy in 2018, the Commission consulted on the technology assumption with stakeholders in 2019. In particular, the technology database of the main model suite (PRIMES, PRIMES-TREMOVE, GAINS, GLOBIOM, and CAPRI) benefited from a dedicated consultation workshop held on 11th November 2019. EU Member States representatives also had the opportunity to comment on the costs elements during a workshop held on 25th November 2019. The updated technology assumptions are published together with the EU Reference Scenario 2020.

*4.1.4 The existing 2030 framework: the EU Reference Scenario 2020*

The EU Reference Scenario 2020 as the common baseline

The EU Reference Scenario 2020 (REF2020) provides projections for energy demand and supply, as well as greenhouse gas emissions in all sectors of the European economy under the current EU and national policy framework. It embeds in particular the EU legislation in place to reach the 2030 climate target of at least 40% compared to 1990, as well as national contributions to reaching the EU 2030 energy targets on Energy efficiency and Renewables under the Governance of the Energy Union. It thus gives a detailed picture of where the EU economy and energy system in particular would stand in terms of GHG emission if the policy framework were not updated to enable reaching the revised 2030 climate target to at least -55% compared to 1990 proposed under the Climate Target Plan[46].

The Reference Scenario serves as the common baseline shared by all the initiatives of the "Fit for 55" policy package to assess options in their impact assessments:

- updating the Effort Sharing Regulation,
- updating the Emission Trading System,
- revision of the Renewables Energy Directive,
- revision of the Energy Efficiency Directive,
- revision of the Regulation setting $CO_2$ emission performance standards for cars and light commercial vehicles,
- review of the LULUCF EU rules.

Difference with the CTP "BSL" scenario

The REF2020 embeds some differences compared to the baseline used for the CTP impact assessment. While the technology assumptions (consulted in a workshop held on 11th November 2019) were not changed, the time between CTP publication and the publication of the "Fit for 55" package allowed updating some other important assumptions:

- GDP projections, population projections and fossil fuel prices were updated, in particular to take into account the impact of the COVID crisis through an

[45] JRC118275
[46] COM/2020/562 final

alignment with the 2021 Ageing Report[47] and an update of international fossil fuel prices notably on the short run.

- While the CTP baseline aimed at reaching the current EU 2030 energy targets (on energy efficiency and renewable energy), the Reference Scenario 2020, used as the baseline for the "Fit for 55" package, further improved the representation of the National Energy Climate Plans (NECP). In particular it aims at reaching the national contributions to the EU energy targets, and not at respecting these EU targets themselves.

Reference scenario process

The REF2020 scenario has been prepared by the European Commission services and consultants from E3Modelling, IIASA and EuroCare, in coordination with Member States experts through the Reference Scenario Experts Group.

It benefitted from a stakeholders consultation (on technologies) and is aligned with other outlooks from Commission services, notably DG ECFIN's Ageing Report 2021, as well as, to the extent possible, the 2020 edition of the EU Agricultural Outlook 2020-2030 published by DG AGRI in December 2020[48].

Policies in the Reference scenario

The REF2020 also takes into account the still-unfolding effects of the COVID-19 pandemic, to the extent possible at the time of the analysis. According to the GDP assumptions of the Ageing Report 2021, the pandemic is followed by an economic recovery resulting in moderately lower economic output in 2030 than pre-COVID estimates.

The scenario is based on existing policies adopted at national and EU level at the beginning of 2020. In particular, at EU level, the REF2020 takes into account the legislation adopted in the Clean Energy for All European Package[49]. At national level, the scenario takes into account the policies and specific targets, in particular in relation with renewable energy and energy efficiency, described in the final National Energy and Climate Plans (NECPs) submitted by Member States at the end of 2019/beginning of 2020.

The REF2020 models the policies already adopted, but not the target of net-zero emissions by 2050. As a result, there are no additional policies introduced driving decarbonisation after 2030. However, climate and energy policies are not rolled back after 2030 and several of the measures in place today continue to deliver emissions reduction in the long term. This is the case, for example, for products standards and building codes and the ETS Directive (progressive reduction of ETS allowances is set to continue after 2030).

Details on policies and measures represented in the REF2020 can be found in the dedicated "EU Reference Scenario 2020" publication.

[47] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

[48] https://ec.europa.eu/info/news/eu-agricultural-outlook-2020-30-agri-food-sector-shown-resilience-still-covid-19-recovery-have-long-term-impacts-2020-dec-16_en

[49] COM(2016) 860 final.

Reference Scenario 2020 key outputs

For 2030, the REF2020 scenario mirrors the main targets and projections submitted by Member States in their final NECPs. In particular, aggregated at the EU level, the REF2020 projects a 33.2% share of renewable energy in Gross Final Energy Consumption. Final energy consumption is 823 Mtoe, which is 29.6% below the 2007 PRIMES Baseline.

In the REF2020, GHG emissions from the EU in 2030 (including all domestic emissions & intra EU aviation and maritime) are 43.8% below the 1990 level. A carbon price of 30 EUR/t$CO_2$eq. in 2030 drives emissions reduction in the ETS sector. The table below shows a summary of the projections for 2030. A detailed description of the REF2020 can be found in a separate report published by the Commission[50].

*Table 41: REF2020 summary energy and climate indicators.*

| EU 2030 | REF2020 |
|---|---|
| GHG reductions (incl. Domestic emissions & intra EU aviation and maritime) vs 1990 | -43.8% |
| RES share | 33.2% |
| PEC energy savings | -32.7% |
| FEC energy savings | -29.6% |
| Environmental impacts | |
| GHG emissions reduction in current ETS sectors vs 2005 | -48.2% |
| GHG emissions reduction in current non-ETS sectors vs 2005 | -30.7% |
| Energy system impacts | |
| GIC (Mtoe) | 1224.2 |
| - Solid fossil fuels | 9.3% |
| - Oil | 31.9% |
| - Natural gas | 22% |
| - Nuclear | 11% |
| - Renewables | 25.8% |
| Final Energy Demand (Mtoe) | 822.6 |
| RES share in heating & cooling | 32.8% |
| RES share in electricity | 58.5% |
| RES share in transport | 21.2% |
| Economic and social impacts | |
| System costs (excl. auction payment) (average 2021-30) as % of GDP | 10.9% |
| Investment expenditures (incl. transport) average annual (2021-30) vs (2011-20) (bn€) | 285 |
| EU ETS carbon price (€/ton, 2030) | 30 |
| Energy- expenditures (excl. transport) of households as % of total consumption | 7.0% |

*Source: PRIMES model*

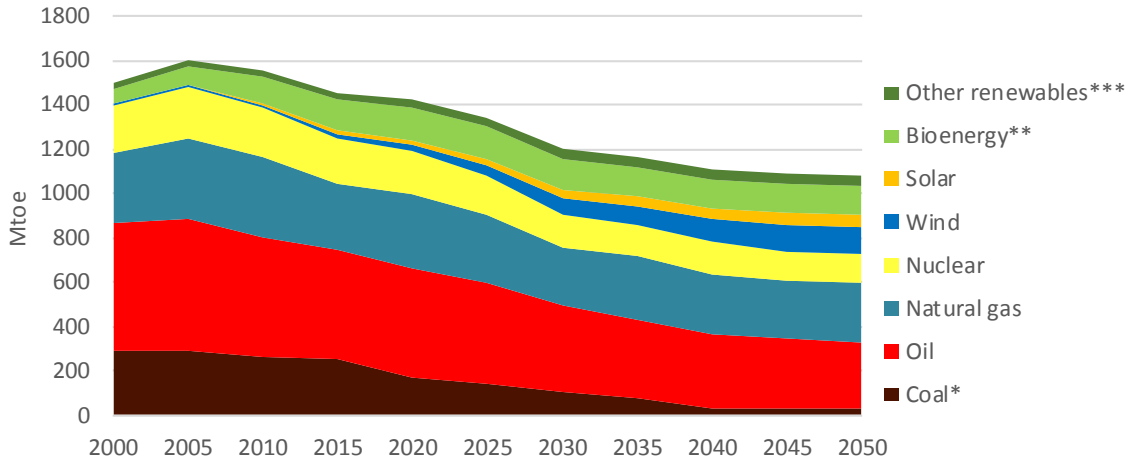
[50] Link to reference.

The system costs (excluding ETS carbon-related payments) reaches close to 11% of the EU's GDP on average over 2021-2030. This cost[51] is calculated ex-post with a private sector perspective applying a flat 10% discount rate[52] over the simulation period up to 2050 to compute investment-related annualized expenditures.

By 2050, final energy consumption is projected at around 790 Mtoe and approximately 74% of the European electricity is generated by renewable energy sources. GHG emissions in the EU are projected to be about 60% lower than in 1990: the REF2020 thus falls short of the European goal of climate neutrality by 2050.

Focusing on the energy system, REF2020 shows that in 2030 fuel mix would still be dominated by fossil fuels. While the renewables grow and fossil fuels decline by 2050, the substitution is not sufficient for carbon neutrality. It also has to be noted that there is no deployment of e-fuels that are crucial for achievement of carbon neutrality as analysed in the Long Term Strategy[53] and in the CTP.

*Figure 71: Fuel mix evolution of the Reference Scenario 2020*



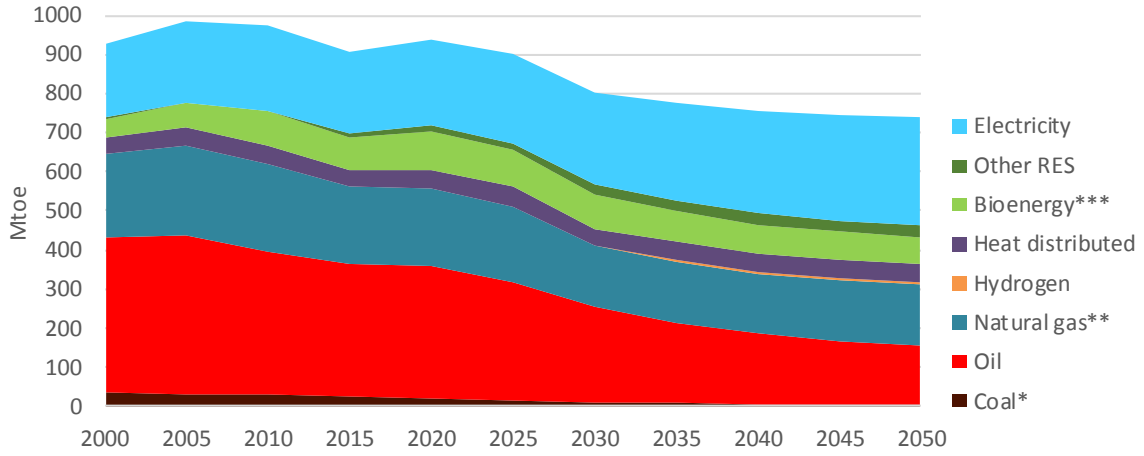

*Source: Eurostat, PRIMES model*

[51] Energy system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy using equipment, appliances and energy related costs of transport), energy purchase costs (fuels + electricity + steam) and direct efficiency investment costs, the latter being also expenditures of capital nature. For transport, only the additional capital costs for energy purposes (additional capital costs for improving energy efficiency or for using alternative fuels, including alternative fuels infrastructure) are covered, but not other costs including the significant transport related infrastructure costs e.g. related to railways and roads. Direct efficiency investment costs include additional costs for house insulation, double/triple glazing, control systems, energy management and for efficiency enhancing changes in production processes not accounted for under energy capital and fuel/electricity purchase costs. Energy system costs are calculated ex-post after the model is solved.

[52] See the EU Reference Scenario 2020 publication for a further discussion on the roles and levels of discount rates in the modelling, which also represent risk and opportunity costs associated with investments.

[53] COM(2018) 773

*Figure 72: Share of energy carriers in final energy consumption in the Reference Scenario 2020*

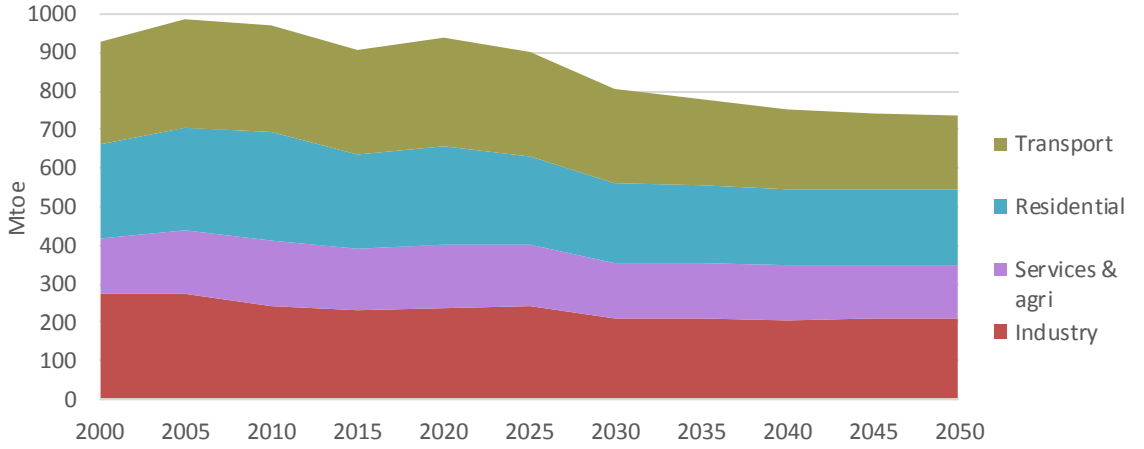



*Note: * includes peat and oil shale; ** includes manufactured gases, *** includes waste*

*Source: Eurostat, PRIMES model*

Coal use in power generation decrease by 62% by 2030 and almost completely disappear by 2050. Also demand for oil sees a significant decrease of 54% over the entire period – the most important in absolute terms. Electricity generation grows by 24% by 2050.

*Figure 73: Final energy demand by sector in the Reference Scenario 2020*




*Source: Eurostat, PRIMES model*

Despite continued economic growth, final energy demand decreases by 18% between 2015 and 2050 (already by 2030 it decreases by more than 8%).

### *4.1.5 Scenarios for the "Fit for 55" policy analysis*

From the Climate Target Plan scenarios to "Fit for 55" core scenarios

In the Climate Target Plan (CTP) impact assessment, the increase of efforts needed for the GHG 55% target was illustrated by policy scenarios (developed with the same modelling suite as the scenarios done for the "Fit for 55" package) showing increased ambition (or stringency) of climate, energy and transport policies and, consequently, leading to a significant investment challenge.

The first key lesson from the CTP exercise was that while the tools are numerous and have a number of interactions (or even sometimes trade-offs) a **complete toolbox of**

**climate, energy and transport policies is needed** for the increased climate target as all sectors would need to contribute effectively towards the GHG 55% target.

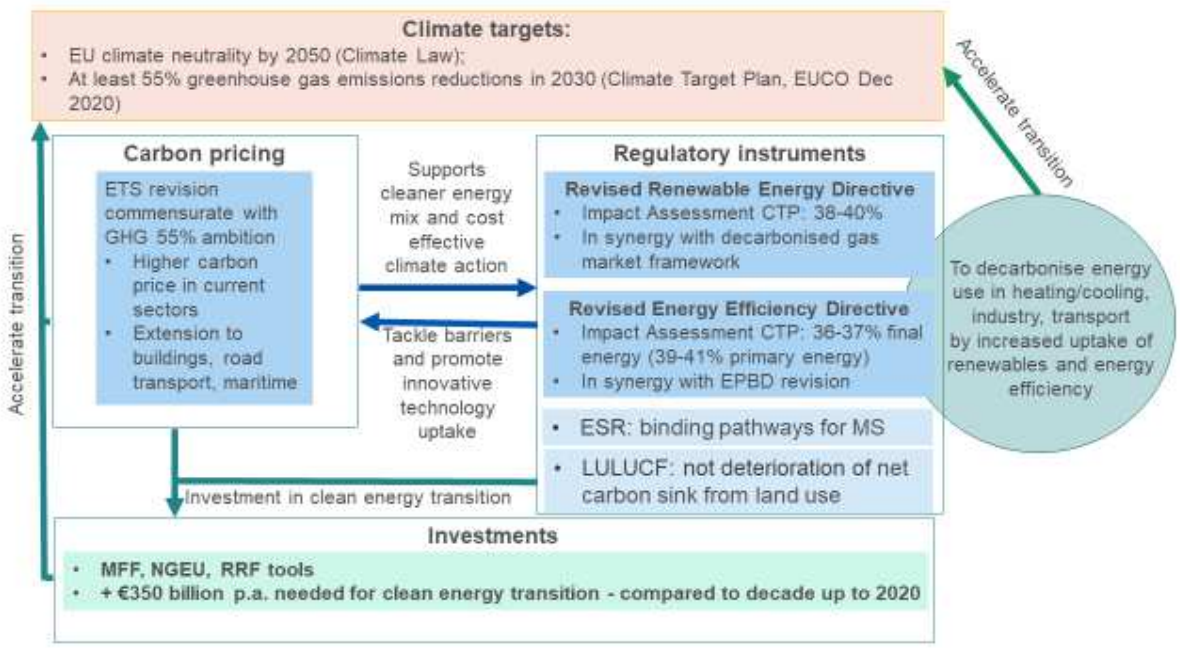
The second key lesson was that even though policy tools chosen in the CTP scenarios were different - illustrating in particular the fundamental interplay between the strength of the carbon pricing and intensity of regulatory measures - **the results achieved were convergent**. All CTP policy scenarios that achieved a 55% GHG target[54] showed very similar levels of ambition for energy efficiency, renewables (overall and on sectoral level) and GHG reductions across the sectors indicating also the cost-effective pathways.

The third lesson was that carbon pricing working hand in hand with regulatory measures helps avoid "extreme" scenarios of either:

- a very high carbon price (in absence of regulatory measures) that will translate into increased energy prices for all consumers,
- very ambitious policies that might be difficult to be implemented (e.g. very high energy savings or renewables obligations) because they would be costly for economic operators or represent very significant investment challenge.

The Figure below illustrates the interactions between different policy tools relevant to reach the EU's climate objectives.

*Figure 74: Interactions between different policy tools*




With the 55% GHG target confirmed by EU leaders in the December 2020 EUCO Conclusions[55] and the 2021 Commission Work Programme[56] (CWP 2021) that puts forward the complete toolbox to achieve the increased climate target (so-called "Fit for 55" proposals), the fundamental set-up of the CTP analysis was confirmed. This set-up is still about the interplay between carbon pricing and regulatory measures as illustrated above, and the extension of the ETS is the central policy question.

[54] A 50% GHG target was also analysed
[55] https://www.consilium.europa.eu/media/47328/1011-12-20-euco-conclusions-fr.pdf
[56] COM(2020) 690 final

As described above, the policy scenarios of the CTP assessment are cost-effective pathways that capture all policies needed to achieve the increased climate target of 55% GHG reductions. This fundamental design remains robust and the CTP scenarios were thus used as the basis to define the "Fit for 55" policy scenarios.

In the context of the agreed increased climate target of a net reduction of 55% GHG compared to 1990, the 50% GHG scenario (CTP MIX-50) explored in the CTP has been discarded since no longer relevant. The contribution of extra EU aviation and maritime emissions in the CTP ALLBNK scenario was assessed in the respective sector specific impact assessments and was not retained as a core scenario. This leaves the following CTP scenarios in need of further revisions and updates in the context of preparing input in a coherent manner for the set of IAs supporting the "Fit for 55" package, ensuring the achievement of the overall net 55% GHG reduction ambition with similar levels of renewable energy and energy efficiency deployment as in CTP:

- CTP REG (relying only on intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors);
- CTP MIX (relying on both carbon price signal extension to road transport and buildings and intensification of energy and transport policies);
- CTP CPRICE (relying chiefly on carbon price signal extension, and more limited additional sectoral policies).

Scenarios for the "Fit for 55"package

Based on the Climate Target Plan analysis, some **updates were needed** though for the purpose of the "Fit for 55" assessment, in terms of:

- **Baseline**:
    - to reflect the most recent statistical data available, notably in terms of COVID impacts,
    - to capture the objectives and policies put forward by Member States in the NECPs, which were not all available at the time of the CTP analysis,

The baseline used in the Fit for 55 package is thus the "Reference Scenario 2020", as described in section above.

- **Scenario design** in order to align better with policy options as put forward in the CWP 2021 and respective Inception Impact Assessments[57].

As a consequence, the three following core policy scenarios were defined to serve as common policy package analysis across the various initiatives of the "Fit for 55" policy assessments:

[57] Importantly, all "Fit for 55" core scenarios reflect the Commission Work Programme (CWP) 2021 in terms of elements foreseen. This is why assumptions are made about legislative proposals to be made later on - by Quarter 4 2021. On the energy side, the subsequent proposals are: the revision of the EPBD, the proposal for Decarbonised Gas Markets and the proposal for reducing methane emissions in the energy sector. For transport they refer to the revision of the TEN-T Regulation and the revision of the ITS Directive. In addition, other policies that are planned for 2022 are also represented in a stylised way in these scenarios, similar to the CTP scenarios. In this way, core scenarios represent all key policies needed to deliver the increased climate target.

- **REG**: an update of the CTP REG case (relying only on very strong intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors).
- **MIX**: reflecting an update of the CTP MIX case (relying on both carbon price signal extension to road transport and buildings and strong intensification of energy and transport policies). With its uniform carbon price (as of 2025), it reflects either an extended and fully integrated EU ETS or an existing EU ETS and new ETS established for road transport and buildings with emission caps set in line with cost-effective contributions of the respective sectors.
- **MIX-CP**: representing a more carbon price driven policy mix, combining thus the general philosophy of the CTP CPRICE scenario with key drivers of the MIX scenario albeit at a lower intensity. It illustrates a revision of the EED and RED but limited to a lower intensification of current policies in addition to the carbon price signal applied to new sectors.
  Unlike MIX, this scenario allows to separate carbon price signals of "current" and "new" ETS. The relative split of ambition in GHG reductions between "current" ETS and "new ETS" remains, however, close in MIX-CP to the MIX scenario leading to differentiated carbon prices between "current" ETS and "new" ETS[58].

These three "Fit for 55" core policy scenarios have been produced starting from the Reference Scenario 2020 and thus use the same updated assumptions on post-COVID economics and international fuel prices.

The table below provides an overview of the policy assumptions retained in the three core policy scenarios. It refers in particular to different scopes of emissions trading system ("ETS"):

- "current+": refers to the current ETS extended to cover also national and international intra-EU maritime emissions[59]: this scope applies to all scenarios,
- "new": refers to the new ETS for buildings and road transport emissions: this scope applies in MIX and MIX-CP up to 2030,
- "large": refers to the use of emissions trading systems covering the "current" scope ETS, intra-EU maritime, buildings and road transport (equivalent to "current+" + "new"): this scope applies in MIX and MIX-CP after 2030.

The scenarios included focus on emissions within the EU, including intra-EU navigation and intra-EU aviation emissions. The inclusion or not of extra-EU navigation and extra-EU maritime emissions is assessed in the relevant sector specific Impact Assessments.

[58] This is a feature not implemented in the CTP CPRICE scenario.

[59] For modelling purposes "national maritime" is considered as equal to "domestic navigation", i.e. also including inland navigation.

*Table 42: Scenario assumptions description (scenarios produced with the PRIMES-GAINS-GLOBIOM modelling suite)*

<table>
<tr><th>Scenario</th><th>REG</th><th>MIX</th><th>MIX-CP</th></tr>
<tr><td rowspan="3">Brief description: ETS</td><td rowspan="3">Extension of “current” ETS to also cover intra-EU maritime navigation[60]<br>Strengthening of “current+” ETS in line with -55% ambition</td><td colspan="2">By 2030: 2 ETS systems:<br>- one “current+” ETS (current extended to intra-EU maritime)<br>- one “new” ETS applied to buildings and road transport<br><br>After 2030: both systems are integrated into one “large” ETS</td></tr>
<tr><td rowspan="2">*Relevant up to 2030*: the 2 ETSs are designed so that they have the same carbon price, in line with -55% ambition</td><td>*Relevant up to 2030:* “current+” ETS reduces emissions comparably to MIX</td></tr>
<tr><td>Lower regulatory intervention resulting in higher carbon price than in MIX, notably in the “new” ETS</td></tr>
<tr><td>Brief description: sectoral policies</td><td>High intensity increase of EE, RES, transport policies versus Reference</td><td>Medium intensity increase of EE, RES and transport policies versus Reference</td><td>Lower intensity increase of EE and RES policies versus Reference.<br>Transport policies as in MIX (except related to $CO_2$ standards)</td></tr>
<tr><td>Target scope</td><td colspan="3">EU27</td></tr>
</table>

[60] “Intra-EU navigation” in this table includes both international intra-EU and national maritime. Due to modelling limitations, energy consumption by “national maritime” is assumed to be the same as “domestic navigation”, although the latter also includes inland navigation.

| **Scenario** | **REG** | **MIX** | **MIX-CP** |
|---|---|---|---|
| Aviation | Intra-EU aviation included, extra-EU excluded | | |
| Maritime navigation | Intra-EU maritime included, extra-EU excluded | | |
| Achieved GHG reduction of the target scope | | | |
| Including LULUCF | Around 55% reductions | | |
| Excluding LULUCF | Around 53% reductions | | |
| Assumed Policies | | | |
| Carbon pricing (stylised, for small industry, international aviation and maritime navigation may represent also other instruments than EU ETS such as taxation or CORSIA for aviation) | | | |
| Stationary ETS | Yes | | |
| Aviation-Intra EU ETS | Yes | | |
| Aviation - Extra EU ETS | Yes: mixture 50/50 carbon pricing (reflecting inclusion in the “current+” / “large” ETS, or taxation, or CORSIA) and carbon value (reflecting operational and technical measures); total equal to the carbon price of the “current+” (up to 2030) / “large” ETS | | |
| Maritime-Intra EU ETS | Yes, carbon pricing equal to the price of the “current+” (up to 2030) / “large” EU ETS | | |

| **Scenario** | **REG** | **MIX** | **MIX-CP** |
|---|---|---|---|
| Maritime-Extra EU ETS | As in MIX (but applied to the "current+" ETS) | Up to 2030: no carbon pricing.<br>After 2030: 50% of extra-EU MRV[61] sees the "large" ETS price, while the remaining 50% sees a carbon value equal to the "large" ETS carbon price. | |
| Buildings and road transport ETS | No | Yes (in the "new" ETS up to 2030, and in the "large" ETS after 2030) | |
| $CO_2$ standards for LDVs and HDVs | $CO_2$ standards for LDVs and HDVs + Charging and refuelling infrastructure development (review of the Directive on alternative fuels infrastructure and TEN-T Regulation & funding), including strengthened role of buildings | | |
| | High ambition increase | Medium ambition increase | Lower ambition increase |
| EE policies overall ambition | High ambition increase | Medium ambition increase | Lower ambition increase |
| EE policies in buildings | High intensity increase (more than doubling of renovation rates assumed) | Medium intensity increase (at least doubling of renovation rates assumed) | Lower intensity increase, no assumptions on renovation rates increases |
| EE policies in transport | High ambition increase | Medium intensity increase | As in MIX |
| RES policies overall ambition | High ambition increase | Medium intensity increase | Lower ambition increase except for transport (see below) |

[61] 50% of all incoming and all outgoing extra-EU voyages

| **Scenario** | **REG** | **MIX** | **MIX-CP** |
|---|---|---|---|
| RES policies in buildings + industry | Incentives for uptake of RES in heating and cooling | Incentives for uptake of RES in heating and cooling | No increase of intensity of policy (compared to Reference) |
| RES policies in transport and policies impacting transport fuels | Increase of intensity of policies to decarbonise the fuel mix (reflecting ReFuelEU aviation and FuelEU maritime initiatives).<br>Origin of electricity for "e-fuels" under the aviation and shipping mandates:<br>up to 2035 (inclusive) "e-fuels" (e-liquids, e-gas, hydrogen) are produced from renewable electricity, applying additionality principle.<br>from 2040 onwards "e-fuels" are produced from "low carbon" electricity (i.e. nuclear and renewable origin). No application of additionality principle.<br>$CO_2$ from biogenic sources or air capture. | | |
| Taxation policies | Central option on energy content taxation of the ETD revision | | |
| Additional non-$CO_2$ policies (represented by a carbon value) | Medium ambition increase | | |

Quantitative elements and key modelling drivers

Policies and measures are captured in the modelling analysis in different manners. Some are explicitely represented such as for instance improved product energy performance standards, fuel mandates or carbon pricing in an emission trading system. Others are represented by modelling drivers ("shadow values") used to achieve policy objectives.

The overall need for investment in new or retrofitted equipment depends on expected future demand and expected scrapping of installed equipment. The economic modelling of the competition among available investment options is based on:

- the investment cost, to which a "private" discount rate is applied to represent risk adverseness of the economic agents in the various sectors[62],
- fuel prices (including their carbon price component),
- maintenance costs as well as performance of installations over the potential lifetime of the installation,
- the relevant shadow values representing energy efficiency or renewable energy policies.

In particular, carbon pricing instruments impact economic decisions related to operation of existing equipment and to investment, in the different sectors where they apply. The table below shows the evolution of the ETS prices by 2030 in the Reference and core scenarios.

*Table 43: ETS prices by 2030 in the difference scenarios (€2015/tCO$_2$)*

| Scenarios | Carbon price "current" ETS sectors | | Carbon price "new" ETS sectors | |
|---|---|---|---|---|
| | 2025 | 2030 | 2025 | 2030 |
| **REF2020** | 27 | 30 | 0 | 0 |
| **REG** | 31 | 42 | 0 | 0 |
| **MIX** | 35 | 48 | 35 | 48 |
| **MIX-CP** | 35 | 52 | 53 | 80 |

The investment decisions are also taken considering foresight of the future development of fuel prices, including future carbon values[63] post 2030. Investment decisions take into account expectations about climate and energy policy developments, and this carbon value achieves in 2050 levels between €360/tCO$_2$ (in REG, where energy policy drivers play comparatively a larger role) and €430/tCO$_2$ (MIX-CP)[64].

In complement to carbon pricing drivers, the modelling uses "shadow values" as drivers to reach energy policy objectives of policies and measures that represent yet to be defined

[62] For more information on the roles and levels of discount rates applied per sector, see the EU Reference Scenario 2020 publication.

[63] Post 2030, carbon values should not be seen as a projected carbon price in emissions trading, but as a shadow value representing a range of policies to achieve climate neutrality that are as yet to be defined.

[64] The foresight and the discounting both influence the investment decisions. While in the modelling the discounting is actually applied to the investment to compute annualised fixed costs for the investment decision, its effect can be illustrated if applied to the future prices instead: for example, the average discounted carbon price in 2030 for the period 2030-2050 for renovation of houses and for heating equipment, applying a 12% discount rate, is €65 in the MIX scenario and €81 in the MIX CP scenario.

policies in the respective fields: the so-called "energy efficiency value" and "renewable energy value", which impact investment decision-making in the model. These values are thus introduced to achieve a certain ambition on energy efficiency, for instance related to national energy efficiency targets and renewable energy targets in the NECPs as represented in the Reference Scenario 2020, or increased renovation rates in buildings and increased sector specific renewable energy ambition related to heating and cooling in the policy scenarios.

The table below shows average 2025-2035 values for the different scenarios. The values in REF2020 reflect the existing policy framework, to meet notably the national energy targets (both energy efficiency and renewable energy) as per the NECPs. They are typically higher in policy scenarios that are based on regulatory approaches than in scenarios that are more based on carbon pricing. The "energy efficiency value" and "renewable energy value" also interact with each other through incentivising investment in options which are both reducing energy demand and increasing the contribution of renewables, like heat pumps. This is for instance the case in the REG scenario, where the comparatively higher "energy efficiency value" complements the "renewable energy value" in contributing to the renewable energy performance of the scenario, notably through the highest heat pump penetration of all scenarios.

*Table 44: Energy efficiency value and renewable energy value (averaged 2025-2035)*

| Scenarios | Average renewables shadow value | Average energy efficiency shadow value |
|---|---|---|
| | (€'15/ MWh) | (€'15/ toe) |
| **REF2020** | 62 | 330 |
| **REG** | 121 | 1449 |
| **MIX** | 61 | 1052 |
| **MIX-CP** | 26 | 350 |

*Specific measures for the transport system*

Policies that aim at improving the efficiency of the transport system (corresponding to row "EE in Transport" in the Table 42, and thus reduce energy consumption and $CO_2$ emissions, are phased-in in scenarios that are differentiated in terms of level of ambition (low, medium, high ambition increase). All scenarios assume an intensification of such policies relative to the baseline. Among these policies, the $CO_2$ emission standards for vehicles are of particular importance. The existing standards[65], applicable from 2025 and from 2030, set binding targets for automotive manufacturers to reduce emissions and thus fuel consumption and are included in the Reference Scenario.

*Medium ambition increase*

[65] The existing legislation sets for newly registered passengers cars, an EU fleet-wide average emission target of 95 $gCO_2$/km from 2021, phased in from 2020. For newly registered vans, the EU fleet-wide average emission target is 147 $gCO_2$ /km from 2020 onward. Stricter EU fleet-wide $CO_2$ emission targets, start to apply from 2025 and from 2030. In particular emissions will have to reduce by 15% from 2025 for both cars and vans, and by 37.5% and 31% for cars and vans respectively from 2030, as compared to 2021. From 2025 on, also trucks manufacturers will have to meet $CO_2$ emission targets. In particular, the EU fleet-wide average $CO_2$ emissions of newly registered trucks will have to reduce by 15% by 2025 and 30% by 2030, compared to the average emissions in the reference period (1 July 2019–30 June 2020). For cars, vans and trucks, specific incentive systems are also set to incentivise the uptake of zero and low-emission vehicles.

In this case, the following policy measures are considered that drive improvements in transport system efficiency and support a shift towards more sustainable transport modes, and lead to energy savings and emissions reductions:

- Initiatives to increase and better manage the capacity of railways, inland waterways and short sea shipping, supported by the TEN-T infrastructure and CEF funding;
- Gradual internalisation of external costs ("smart" pricing);
- Incentives to improve the performance of air navigation service providers in terms of efficiency and to improve the utilisation of air traffic management capacity;
- Incentives to improve the functioning of the transport system: support to multimodal mobility and intermodal freight transport by rail, inland waterways and short sea shipping;
- Deployment of the necessary infrastructure, smart traffic management systems, transport digitalisation and fostering connected and automated mobility;
- Further actions on clean airports and ports to drive reductions in energy use and emissions;
- Measures to reduce emissions and air pollution in urban areas;
- Pricing measures such as in relation to energy taxation and infrastructure charging;
- Revision of roadworthiness checks;
- Other measures incentivising behavioural change;
- Medium intensification of the $CO_2$ emission standards for cars, vans, trucks and buses (as of 2030), supported by large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 50% for cars and around 40% for vans.

*Low ambition increase*

In this case, the same policy measures as in the *Medium ambition increase* are included. However, limited increase in ambition for $CO_2$ emission standards for vehicles (passenger cars, vans, trucks and buses) as of 2030 is assumed, supported by the roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 40% for cars and around 35% for vans.

*High ambition increase*

Beyond measures foreseen in the medium ambition increase case, the high ambition increase case includes:

- Further measures related to intelligent transport systems, digitalisation, connectivity and automation of transport - supported by the TEN-T infrastructure;
- Additional measures to improve the efficiency of road freight transport;
- Incentives for low and zero emissions vehicles in vehicle taxation;
- Increasing the accepted load/length for road in case of zero-emission High Capacity Vehicles;
- Additional measures in urban areas to address climate change and air pollution;
- Higher intensification of the $CO_2$ emission standards for cars, vans, trucks and buses (as of 2030) as compared to the medium ambition increase case, leading to lower $CO_2$ emissions and fuel consumption and further incentivising the deployment of zero- and low-emission vehicles, supported by the large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 60% for cars and around 50% for vans.

*Drivers of reduction in non-$CO_2$ GHG emissions*

Non-$CO_2$ GHG emission reductions are driven by both the changes taking place in the energy system due to the energy and carbon pricing instruments, and further by the application of a

carbon value that triggers further cost efficient mitigation potential (based on the GAINS modelling tool) in specific sectors such as waste, agriculture or industry.

*Table 45: Carbon value applied to non-$CO_2$ emissions in the GAINS model (€2015/t$CO_2$)*

| Scenarios | Non-$CO_2$ carbon values | |
|---|---|---|
| | 2025 | 2030 |
| **REF2020** | 0 | 0 |
| **REG** | 4 | 4 |
| **MIX** | 4 | 4 |
| **MIX-CP** | 5 | 10 |

## Key results and comparison with Climate Target Plan scenarios

*Table 46: Key results of the "Fit for 55" core scenarios analysis for the EU*

| **2030 unless otherwise stated** | | REF | REG | MIX | MIX-CP |
|---|---|---|---|---|---|
| **Key results** | | | | | |
| GHG emissions* reductions (incl. intra EU aviation and maritime, incl. LULUCF) | % reduction from 1990 | 45% | 55% | 55% | 55% |
| GHG emissions* reductions (incl. intra EU aviation and maritime, excl. LULUCF) | % reduction from 1990 | 43.4% | 53.0% | 52.9% | 52.9% |
| Overall RES share | % | 33% | 40% | 38% | 38% |
| RES-E share | % | 59% | 65% | 65% | 65% |
| RES-H&C share | % | 33% | 41% | 38% | 36% |
| RES-T share | % | 21% | 29% | 28% | 27% |
| PEC energy savings | % reduction from 2007 Baseline | 33% | 39% | 39% | 38% |
| FEC energy savings | % reduction from 2007 Baseline | 30% | 37% | 36% | 35% |
| **Environmental impacts** | | | | | |
| $CO_2$ emissions reductions (intra-EU scope, excl. LULUCF), of which | (% change from 2015) | -30% | -43% | -42% | -42% |
| Supply side (incl. power generation, energy branch, refineries and district heating) | (% change from 2015) | -49% | -62% | -63% | -64% |
| Power generation | (% change from 2015) | -51% | -64% | -65% | -67% |
| Industry (incl. process emissions) | (% change from 2015) | -10% | -23% | -23% | -23% |
| Residential | (% change from 2015) | -32% | -56% | -54% | -50% |
| Services | (% change from 2015) | -36% | -53% | -52% | -48% |
| Agriculture (energy) | (% change from 2015) | -23% | -36% | -36% | -35% |
| Transport (incl. domestic and intra EU aviation and navigation) | (% change from 2015) | -17% | -22% | -21% | -21% |
| Non-$CO_2$ GHG emissions reductions (excl. LULUCF) | (% change from 2015) | -22% | -32% | -32% | -33% |
| Reduced air pollution vs. REF | (% change) | | | -10% | |
| Reduced health damages and air pollution control cost vs. REF - Low estimate | (€ billion/year) | | | 24.8 | |
| Reduced health damages and air pollution control cost vs. REF - High estimate | (€ billion/year) | | | 42.7 | |
| **Energy system impacts** | | | | | |
| Primary Energy Intensity | toe/M€'13 | 83 | 75 | 76 | 76 |
| Gross Available Energy (GAE) | Mtoe | 1,289 | 1,194 | 1,198 | 1,205 |
| - Solids share | % | 9% | 6% | 5% | 5% |
| - Oil share | % | 34% | 33% | 33% | 33% |
| - Natural gas share | % | 21% | 20% | 20% | 21% |
| - Nuclear share | % | 10% | 11% | 11% | 11% |
| - Renewables share | % | 26% | 31% | 30% | 30% |
| - Bioenergy share | % | 13% | 13% | 12% | 12% |
| - Other Renewables share | % | 13% | 18% | 18% | 18% |

| | | | | | |
|---|---|---|---|---|---|
| Gross Electricity Generation | TWh | 2,996 | 3,152 | 3,154 | 3,151 |
| - Gas share | % | 14% | 12% | 13% | 14% |
| - Nuclear share | % | 17% | 16% | 16% | 16% |
| - Renewables share | % | 59% | 65% | 65% | 65% |
| **Economic impacts** | | | | | |
| Investment expenditures (excl. transport) (2021-30) | bn €'15/year | 297 | 417 | 402 | 379 |
| Investment expenditures (excl. transport) (2021-30) | % GDP | 2.1% | 3.0% | 2.9% | 2.7% |
| *Additional investments to REF* | *bn €'15/year* | | *120* | *105* | *83* |
| Investment expenditures (incl. transport) (2021-30) | bn €'15/year | 944 | 1068 | 1051 | 1028 |
| Investment expenditures (incl. transport) (2021-30) | % GDP | 6.8% | 7.7% | 7.6% | 7.4% |
| *Additional investments to REF* | *bn €'15/year* | | *124* | *107* | *84* |
| *Additional investments to 2011-20* | *bn €'15/year* | *285* | *408* | *392* | *368* |
| Energy system costs excl. carbon pricing and disutility (2021-30) | bn €'15/year | 1518 | 1555 | 1550 | 1541 |
| Energy system costs excl. carbon pricing and disutility (2021-30) | % GDP | 10.9% | 11.2% | 11.15% | 11.1% |
| Energy system costs incl. carbon pricing and disutility (2021-30) | bn €'15/year | 1535 | 1598 | 1630 | 1647 |
| Energy system costs incl. carbon pricing and disutility (2021-30) | % GDP | 11.0% | 11.5% | 11.7% | 11.8% |
| ETS price in current sectors (and maritime) | €/$tCO_2$ | 30 | 42 | 48 | 52 |
| ETS price in new sectors (buildings and road transport) | €/$tCO_2$ | 0 | 0 | 48 | 80 |
| Average Price of Electricity | €/MWh | 158 | 156 | 156 | 157 |
| Import dependency | % | 54% | 52% | 53% | 53% |
| Fossil fuels imports bill savings compared to REF (2021-30) | bn €'15 | | 136 | 115 | 99 |
| Energy-related expenditures in buildings (excl. disutility) | % of private consumption | 6.9% | 7.5% | 7.5% | 7.4% |
| Energy-related expenditures in transport (excl. disutility) | % of private consumption | 18.1% | 18.1% | 18.3% | 18.5% |

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt $CO_2$-eq. in 1990 and 225 Mt $CO_2$-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[66].*

*Source: PRIMES model, GAINS model*

*Table 47: Comparison with the CTP analysis*

| Results for 2030 | CTP 55% GHG reductions scenarios range (REG, MIX, CPRICE, ALLBNK) | "Fit for 55" core scenarios range (REG, MIX, MIX-CP) |
|---|---|---|
| Overall net GHG reduction (w.r.t. 1990)* | 55% | 55% |

[66] Emissions estimates for 1990 are based on EU UNFCCC inventory data 2020, converted to IPCC AR5 Global Warming Potentials for notably methane and nitrous oxide. However, international intra-EU aviation and international intra-EU navigation are not separated in the UNFCCC data from the overall international bunker fuels emissions. Therefore, 1990 estimates for the intra-EU emissions of these sectors are based on (a combination of) data analysis for PRIMES modelling and 2018-2019 MRV data for the maritime sector.

| | | |
|---|---|---|
| Overall RES share | 38-40% | 38-40% |
| RES-E | 64-67% | 65% |
| RES-H&C | 39-42% | 36-41% |
| RES-T | 22-26% | 27-29% |
| FEC EE | 36-37% | 35-37% |
| PEC EE | 39-41% | 38-39% |
| $CO_2$ reduction on the supply side (w.r.t. 2015) | 67-73% | 62-64% |
| $CO_2$ reduction in residential sector (w.r.t. 2015) | 61-65% | 50-56% |
| $CO_2$ reduction in services sector (w.r.t. 2015) | 54-61% | 48-53% |
| $CO_2$ reduction in industry (w.r.t. 2015) | 21-25% | 23% |
| $CO_2$ reduction in intra-EU transport (w.r.t. 2015) | 16-18% | 21-22% |
| $CO_2$ reduction in road transport (w.r.t. 2015) | 19-21% | 24-26% |
| Non-$CO_2$ GHG reductions (w.r.t. 2015, excl. LULUCF) | 31-35% | 32-33% |
| Investments magnitude, excluding transport (in bn€/per year) | 401-438 bn/year | 379-417 bn/per year |
| Energy system costs (excl. auction payments and disutility) as share of GDP (%, 2021-2030) | 10.9-11.1% | 11.1-11.2% |

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt $CO_2$-eq. in 1990 and 225 Mt $CO_2$-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[66] (except the CTP ALLBNK that achieves 55% net reductions including also emissions from extra-EU maritime and aviation).*

*Source: PRIMES model, GAINS model*

### *4.1.6 Results per Member State*

This document is completed by detailed modelling results at EU and MS level for the different core policy scenarios:

- Energy, transport and overall GHG (PRIMES model)
- Details on non-$CO_2$ GHG emissions (GAINS model)
- LULUCF emissions (GLOBIOM model)
- Air pollution (GAINS model)

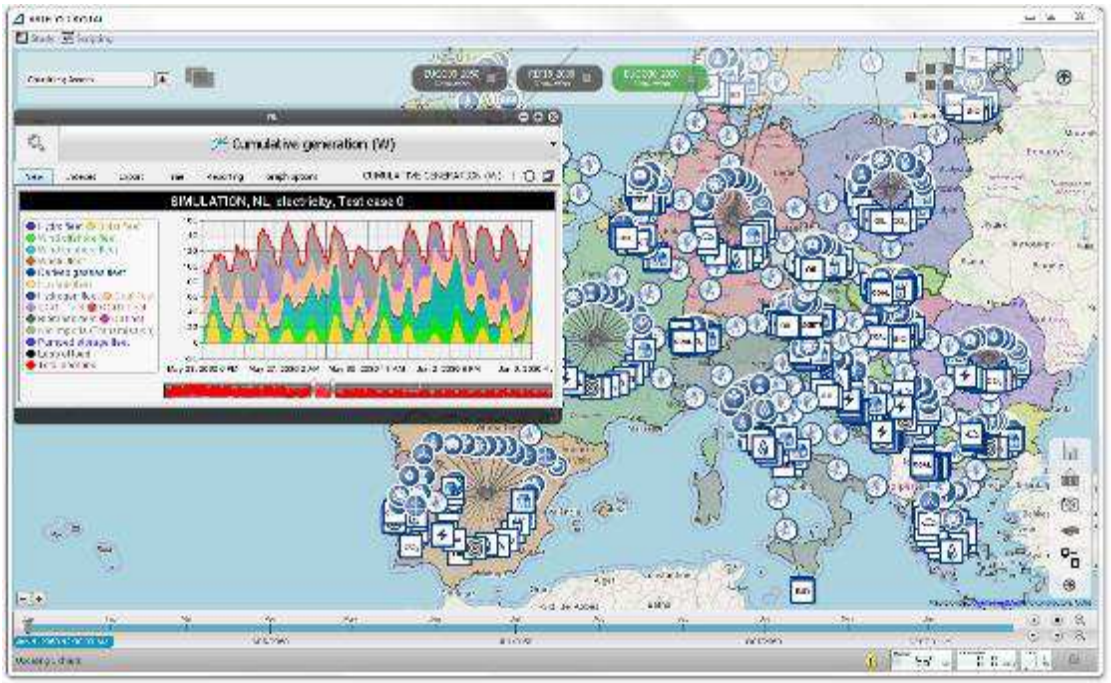
That can be found in "Technical Note on the Results of the "Fit for 55" core scenarios for the EU Member States".

## 4.2 Specific analytical elements for this impact assessment – modelling of the electricity system (with METIS model)

METIS is a project[67] initiated by DG ENER for the development of a computer program consisting of modules and datasets titled METIS, with the aim to further support DG ENER's evidence-based policy making, especially in the areas of electricity and gas. The software is developed by Artelys with the support of IAEW (RWTH Aachen University), ConGas and Frontier Economics as part of Horizons 2020 and is closely followed by DG ENER. METIS first version was delivered at the DG ENER premises in February 2016.

The METIS project provides DG ENER with an in-house tool that can provide insights and robust answers to complex economic and energy related questions, focusing on the short-term operation of the energy system and markets. METIS was used in the impact assessment of the Market Design Initiative.[68]

*Table 48 - METIS models displayed in the Crystal Super Grid user interface*



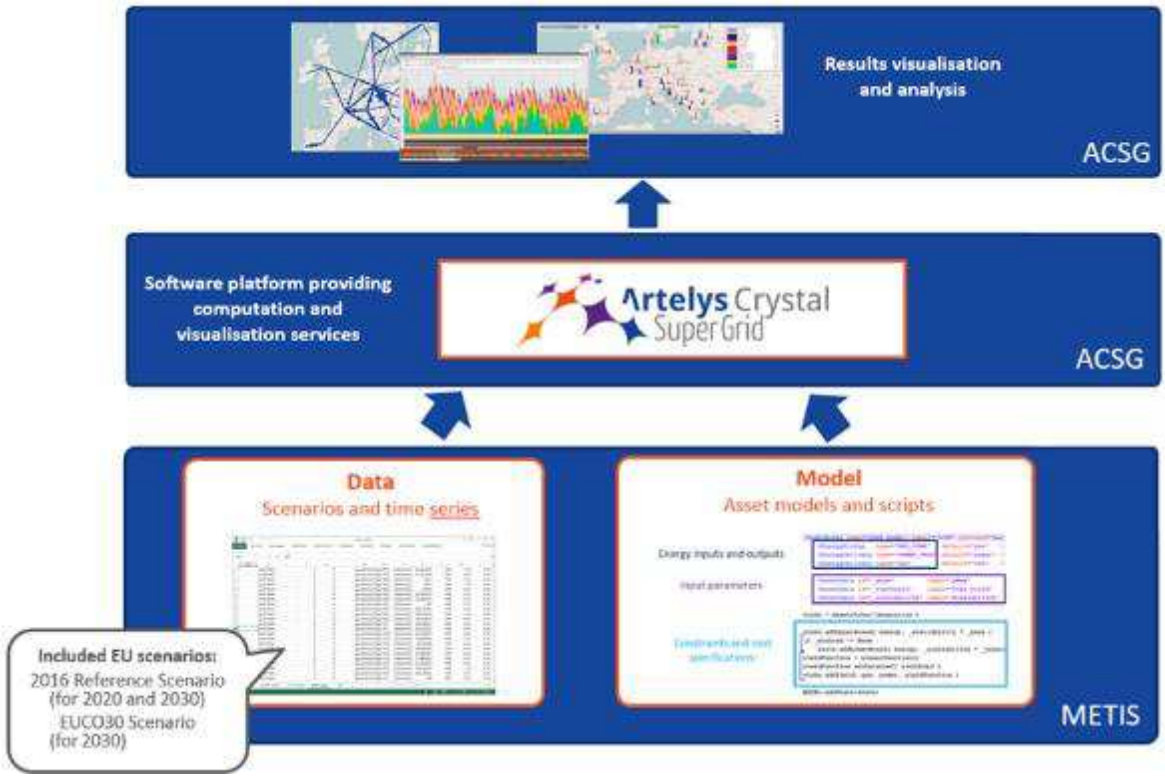

[67] http://ec.europa.eu/dgs/energy/tenders/doc/2014/2014s_152_272370_specifications.pdf
[68] https://ec.europa.eu/energy/sites/ener/files/documents/metis_s12_-_assessing_market_design_options.pdf

**Purpose of this note**

This note should be seen as an entry point for anyone interested in the understanding of the METIS models. One of the main objectives of this note is to present the available documentation, source code and data used in METIS and explain how to use them to understand the model operation. With this note and the associated elements, the reader will be able to fully understand the equations behind the different energy models, apprehend how energy scenarios are built, and learn which indicators are available to analyse the results of a simulated energy scenario.

METIS currently relies on the Artelys Crystal Super Grid Platform (ACSG)[69] to run the model and visualise input data and results. The different METIS models and indicators are run and calculated by the ACSG platform, which also provides a convenient graphical user interface allowing users to easily modify, launch the computations of, and analyse METIS energy scenarios.

*Figure 75 - METIS open-book approach*




**Scenarios for policy analysis with model METIS**

**Baseline:** Limited demand-response. In this scenario, 30% of EVs' and heat-pumps' demands are assumed to be flexible, their operation being based on the hourly electricity price (reflecting real-time pricing, RTP). The remaining demand does not feature any flexible operation, meaning that cars charge immediately when they are connected to the charging point and heat pumps operate when demand occurs (no heat storage is considered). This share reflects what is understood as the minimum level of flexibility required to achieve the CTP

[69] https://www.artelys.com/fr/applications/artelys-super-grid

level of ambition. However, this option is already considered too ambitious given the current situation where flexibility is practically 0%.

**High demand-response (high-DR).** This model run features a higher flexibility share, as 70% of EVs and heat pumps feature flexible demand. This strategy is expected to reduce further the system costs, and help integrating renewables.

**High demand-response with vehicle-to-grid (high-DR-V2G).** In this model run, in addition to 70% flexible demand of EVs and heat pumps, it is also considered that EVs can use the energy stored in their batteries to inject electricity in the grid (vehicle-to-grid). It provides an additional flexibility potential to the system.

**Demand-response to a combined price and vRES signal (DR-vRES-share).** This model run considers that 70% of heat pumps and EVs (no V2G capabilities considered) respond to a signal combining the retail electricity price and a second price component based on the real-time share of vRES in electricity generation.

**Hourly GO option:**

In order to account for consumers' response to the hourly vRES share in electricity generation, an indirect representation of hourly GOs and its associated price is integrated into METIS.

In addition to the hourly electricity price, the consumer is exposed to the hourly GO price, which is assumed to vary as a piecewise linear function of the hourly vRES share. When the vRES generation exceeds a given threshold, the GO price falls to 0 due to oversupply conditions. The threshold is set at a 30% RES share in power generation in this analysis.

However, when renewable generation is lower than the specified threshold, offtakers are competing for GOs. For this model run, the price is assumed to rise linearly with the decrease in vRES generation, until reaching a maximum when almost no renewable generation is available. For this exercise, this maximum is called *scarcity price*.

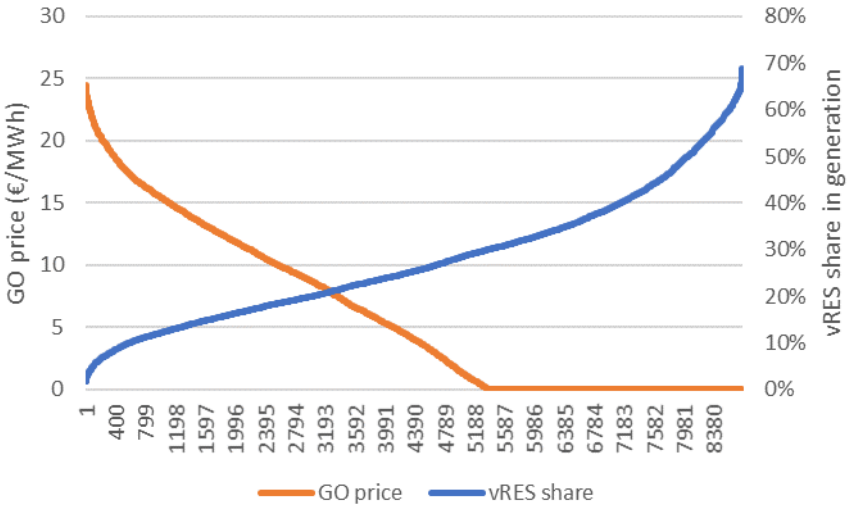
Setting this scarcity price defines the overall shape of GOs price curve against renewable generation. Considering the hourly vRES-share extracted from the high-DR model run, one can compute the average GO price over the year. This annual GO price is expressed in comparable terms with respect to current GO prices (which typically range between 0.1 and 2 €/MWh, reaching up to 10 €/MWh in selected cases), which can be cancelled within a year. In total, three model runs are considered in which the scarcity price varies in order to reach different average GO prices. The average GO prices equal 2, 4 and 10 €/MWh, in contrast to the mean wholesale electricity price of 46 to 50 €/MWh under the MIX scenario in 2030.

*Table 49 - scarcity and average GO price per demand scenario*[70]

| | Low demand | Medium demand | High demand |
|---|---|---|---|
| **Scarcity price** | 13 €/MWh | 26 €/MWh | 65 €/MWh |
| **Average price** | 2 €/MWh | 4 €/MWh | 10 €/MWh |

[70] The EU27 average electricity price in the MIX scenario is between 46 and 50 €/MWh

*Figure 76 - vRES share against GO price duration curve - FR - medium demand scenario*




Setting a GO-price reflecting the hourly vRES share on top of the retail electricity price provides a financial incentive for the consumer to operate at hours that benefit the most to the system in terms of renewables integration. In particular, as displayed on the load duration curves in the table and figure above, some hours feature the same electricity price, indistinctively of the actual vRES share, therefore the electricity price alone does not provide the appropriate signal to a consumer trying to identify hours with higher vRES shares. Setting a GO price on top of the electricity price provides a complementary signal that favours renewables consumption.

However, it should be noted that adding a renewable signal on top of the electricity price could shift the consumer operation to hours featuring higher electricity prices, instead of relying on cheap electricity generation, e.g., from nuclear energy. This consumption pattern modification may increase renewables integration at the expense of the overall system costs.

*Figure 77 - vRES share against electricity price duration curve - FR - medium demand scenario*

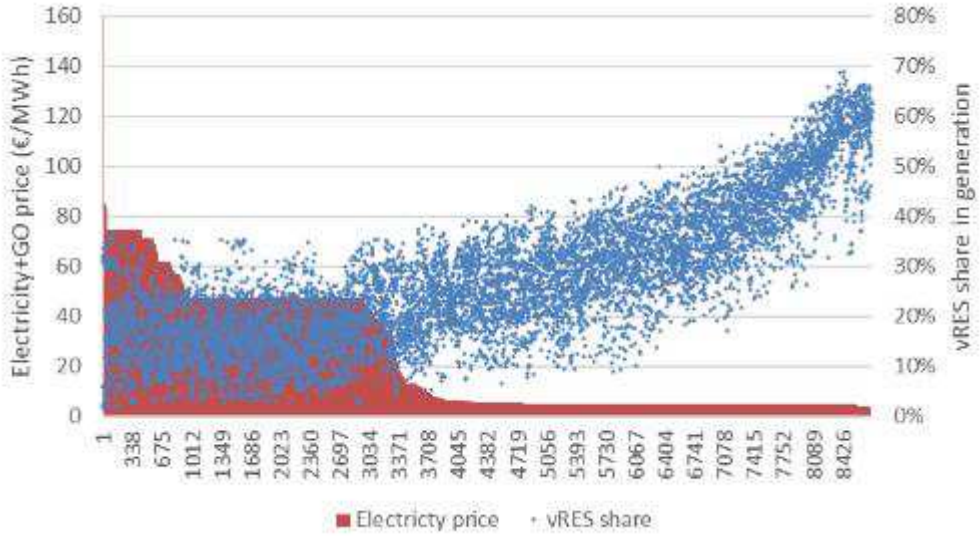
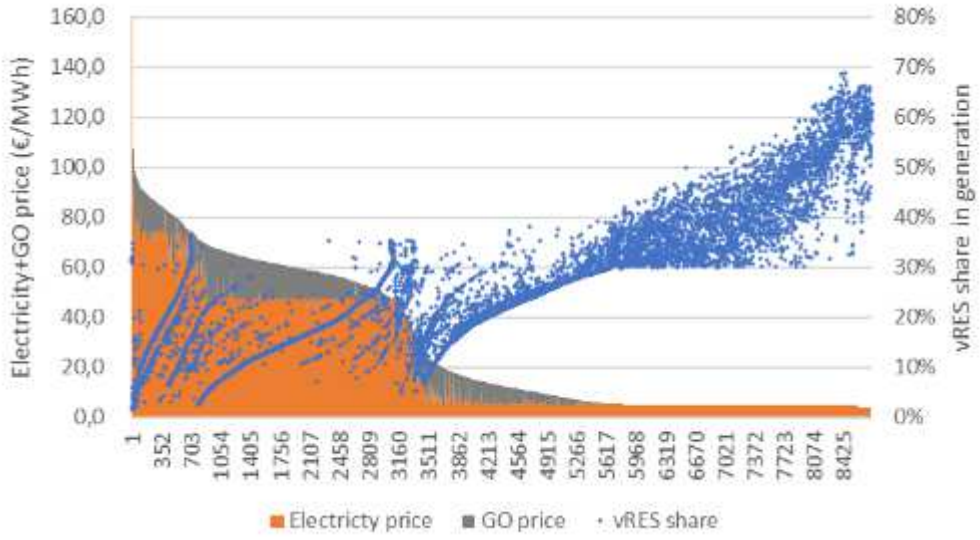



*Figure 78 - vRES share against total electricity price (incl. GOs) duration curve - FR - medium demand scenario*



## ANNEX 5: 2030 CLIMATE TARGET PLAN POLICY CONCLUSIONS

The Communication on stepping up Europe's 2030 climate ambition - the Climate Target Plan (CTP)[71] and its underpinning impact assessment are the starting point for the initiatives under the Fit for 55 package.

The plan concluded on the feasibility - from a technical, economic and societal point of view - of increasing the EU climate target to 55% net reductions of greenhouse gases (GHG) emissions by 2030 compared to 1990. It also concluded that all sectors need to contribute to this target.

In particular, with energy supply and use responsible for 75% of emissions, the plan put forward ambition ranges for renewables and energy efficiency, which correspond in a cost-efficient manner to the increased climate target. The climate target plan also established that this increase in climate and energy ambition will require a full update of the current climate and energy policy framework, undertaken in a coherent manner.

As under the current policy framework, the optimal policy mix should combine, at the EU and national levels, strengthened economic incentives (carbon pricing) with updated regulatory policies, notably in the field of renewables, energy efficiency and sectoral policies such as $CO_2$ standards for new light duty vehicles. It should also include the enabling framework (research and innovation policies, financial support, addressing social concerns).

While sometimes working in the same sectors, the policy tools vary in the way they enable the achievement of the increased climate target. The economic incentives provided by strengthened and expanded emissions trading will contribute to the cost-effective delivery of emissions reductions. The regulatory policies, such as the Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), the Regulation on $CO_2$ standards for vehicles supported by the Directive on the alternative fuels infrastructure, and the Re(FuelEU) aviation and maritime initiatives, aim at addressing market failures and other barriers to decarbonisation, but also create an enabling framework for investment, which supports cost-effective achievement of climate target by reducing perceived risks, increasing the efficient use of public funding and helping to mobilise and leverage private capital. The regulatory policies also pave the way for the future transition needed to achieve the EU target of the climate neutrality. Such a sequential approach from the CTP to the Fit for 55 initiatives was necessary in order to ensure coherence among all initiatives and a collective delivery of the increased climate target.

With the "MIX" scenario, the impact assessment included a policy scenario that largely reflects the political orientations of the plan.

The final calibration between the different instruments is to be made depending, *inter alia* on the decision on the extension of emissions trading beyond the maritime sector and its terms.

The table below shows the summary of the key CTP findings:

*Table 50: Key policy conclusions of the Climate Target Plan*

| POLICY CONCLUSIONS IN THE CTP | |
|---|---|
| GHG emissions reduction | • At least 55% net reduction (w.r.t. 1990)<br>• Agreed by the European Council in December 2020<br>• Politically agreed by the European Council and the European Parliament in |

[71] COM (2020) 562 final.

| | |
|---|---|
| | the Climate Law |
| ETS | • Corresponding targets need to be set in the EU ETS and the Effort Sharing Regulation to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met.<br>• Increased climate target requires strengthened cap of the existing EU ETS and revisiting the linear reduction factor.<br>• Further expansion of scope is a possible policy option, which could include emissions from road transport and buildings, looking into covering all emissions of fossil fuel combustion.<br>• EU should continue to regulate at least intra-EU aviation emissions in the EU ETS and include at least intra-EU maritime transport in the EU ETS.<br>• For aviation, the Commission will propose to reduce the free allocation of allowances, increasing the effectiveness of the carbon price signal in this sector, while taking into account other policy measures. |
| ESR | • Corresponding targets need to be set in the Effort Sharing Regulation and under the EU ETS, to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met. |
| LULUCF | • Sink needs to be enhanced.<br>• Agriculture forestry and land use together have the potential to become rapidly climate-neutral by around 2035 and subsequently generate removals consistent with trajectory to become climate neutral by 2050. |
| CO2 standards for cars and vans | • Transport policies and standards will be revised and, where needed, new policies will be introduced.<br>• The Commission will revisit and strengthen the $CO_2$ standards for cars and vans for 2030.<br>• The Commission will assess what would be required in practice for this sector to contribute to achieving climate neutrality by 2050 and at what point in time internal combustion engines in cars should stop coming to the market. |
| Non-CO2 GHG emissions | • The energy sector has reduction potential by avoiding fugitive methane emissions. The waste sector is expected to strongly reduce its emissions already under existing policies. Turning waste into a resource is an essential part of a circular economy, as is prevention of waste, addressed by both Circular Economy and the Zero Pollution Action Plans. Under existing technology and management options, agriculture emissions cannot be eliminated fully but they can be significantly reduced while ensuring food security is maintained in the EU. Policy initiatives have been included in the Methane Strategy. |
| Renewables | • 38-40% share needed to achieve increased climate target cost-effectively.<br>• Renewable energy policies and standards will be revised and, where needed, new policies will be introduced.<br>• Relevant legislation will be reinforced and supported by the forthcoming Commission initiatives on a Renovation Wave, an Offshore Energy strategy, alternative fuels for aviation and maritime as well as a Sustainable and Smart Mobility Strategy.<br>• EU action to focus on cost-effective planning and development of renewable energy technologies, eliminating market barriers and providing sufficient incentives for demand for renewable energy, particularly for end-use sectors such as heating and cooling or transport either through electrification or via the use of renewable and low-carbon fuels such as advanced biofuels or other sustainable alternative fuels.<br>• The Commission to assess the nature and the level of the existing, indicative heating and cooling target, including the target for district |

| | |
|---|---|
| | heating and cooling, as well as the necessary measures and calculation framework to mainstream further renewable and low carbon based solutions, including electricity, in buildings and industry.<br>• An updated methodology to promote, in accordance with their greenhouse gas performance, the use of renewable and low-carbon fuels in the transport sector set out in the Renewable Energy Directive.<br>• A comprehensive terminology for all renewable and low-carbon fuels and a European system of certification of such fuels, based notably on full life cycle greenhouse gas emissions savings and sustainability criteria, and existing provisions for instance in the Renewable Energy Directive.<br>• Increase the use of sustainably produced biomass and minimise the use of whole trees and food and feed-based crops to produce energy through inter alia reviewing and revisiting, as appropriate, the biomass sustainability criteria in the Renewable Energy Directive, |
| Energy Efficiency | • Energy efficiency policies and standards will be revised and, where needed, new policies will be introduced.<br>• Energy efficiency improvements will need to be significantly stepped up to around 36-37% in terms of final energy consumption[72].<br>• Achievement of a more ambitious energy efficiency target and closure of the collective ambition gap of the national energy efficiency contributions in the NECPs will require actions on a variety of fronts.<br>• Renovation Wave will launch a set of actions to increase the depth and the rate of renovations at single building and at district level, switch fuels towards renewable heating solutions, diffuse the most efficient products and appliances, uptake smart systems and building-related infrastructure for charging e-vehicles, and improve the building envelope (insulation and windows).<br>• Action will be taken not only to better enforce the Energy Performance of Buildings Directive, but also to identify any need for targeted revisions.<br>• Establishing mandatory requirements for the worst performing buildings and gradually tightening the minimum energy performance requirements will also considered. |

[72] The Impact Assessment identifies a range of 35.5% - 36.7% depending on the overall design of policy measures underpinning the new 2030 target. This would correspond to a range of 39.2% - 40.6% in terms of primary energy consumption.

## ANNEX 6: DISCARDED OPTIONS

### 1. Options on target setting

Possible scenarios representing 2030 EU GHG emissions reduction target below 55% or higher were discarded at an early stage as they do not fulfil the political mandate agreed by EU leaders. In line with this agreement, policy options assessed look at the impact of achieving the resulting 38-40% renewable energy shares. Lower or higher shares of renewables would diverge from the cost-effective pathways established in the CTP.

During the 1st stakeholder meeting, panellists from the different sessions reflected a positive attitude towards the increase of the overall target. In addition, polls conducted during the workshop showed that the top 3 sectors where additional efforts are considered necessary to meet higher renewables targets for 2030 are the transport sector, heating and cooling, and buildings. In addition 66% of participant in the workshop think that the overall renewable target should be binding at both national levels and EU levels.

Some stakeholders have asked for a higher target – beyond 40% renewable energy shares or renewable electricity share of 100% by 2030 respectively but such scenarios resulting in EU GHG reductions target of over 55% were not assessed in this IA. No scenarios without increasing energy efficiency and renewable energy ambition - one of them or both - were analysed as they would depart from current legislation and miss on synergies that are crucial for a cost-effective achievement of 2030 GHG target. The experience with policies to date proves that the targets for GHG emissions reduction, RES and EE ambition reinforce each other. The objective of this impact assessment is to assess an increase of renewable energy in line with the 55% GHG reductions in a responsible manner, following the European Green Deal and as approved by EU leaders, which will require mitigating all negative social and economic impacts associated with the transition.

Scenarios in this Impact Assessment take into account existing EU and national policies, including regarding their energy mix, and aim for a future policy mix that is coherent to implement. This is why no scenarios were developed that would put an exaggerated burden of the decarbonisation transition on a specific sector or technology or have an asymmetric distribution of effort or would be inconsistent with the progress achieved so far.

The options of updating and aligning the necessary legislative framework to include an earlier mandatory resubmission of the updates to the NECPs (including the national contributions to the RES targets) was also discarded. This resubmission will be required for the short-term, well before the scheduled 2023 (draft updates) and 2024 (final updates) submission and would have ensured that Member States reconsider their national contributions to a potentially increased EU RES target at the earliest opportunity. Although this option would probably result in earlier action to realise the increased ambition levels but also in additional administrative burden. Furthermore, this option may require legislative changes which may be challenging to deliver in such a short timeframe and may therefore hamper the feasibility of this option.

### 2. Options on promotion of low carbon and renewable fuels

In this set of options, option 4 (creation of specific targets for low-carbon fuels such as blue hydrogen) was discarded at an early stage. Low carbon fuels will be needed in a transition period on the way to a net-zero economy. A specific promotion under the Renewable

Directives would however not be in line with the spirit of the Directive and risks setting the wrong incentives leading to stranded assets and to a more difficult transition to net-zero emissions in 2050. Option 3 (accounting of low carbon fuels for sectoral transport and heating & cooling targets) was also discarded as such a measure would likely push out more expensive renewable fuels in fulfilling these sub-targets.

3. Options on bioenergy sustainability

In the set of policy options on bioenergy sustainability, the following policy options were discarded at an early stage.

***Applying the sustainability criteria only at forest unit level.*** Under this option, compliance with the new sustainability criteria for forest biomass would be applied only at the level of forest sourcing areas or forest units and they would be demonstrated by means of certification. The option is discarded due to proportionality (high increase of costs for forest owners) and subsidiarity. First, the requirement to apply the criteria at forest unit level would impose a heavy burden on private forest owners, in particular for small forest owners. Indeed, the certification/verification costs would represent an important/excessive share of forest owners' incomes, in particular considering the lower value often paid for wood for fuel versus other uses. This would imply that wood producers would be unwilling to take up certification/verification in order to demonstrate compliance. This will be particularly true for small/local operators[73]. Thus, this would question the effectiveness of this option. This option also overlooks the very different characteristics of the forest sector in the EU. For instance, the recent JRC biomass study acknowledges that about half of the stemwood used for bioenergy comes from coppice forests. In view of the very limited economic return of this type of forests (only harvested in long time frames), requesting compliance with the sustainability criteria would render their management totally uneconomic. Similarly for biomass coming from forest fire prevention treatments and other phyto-sanitary and restoration measures, which are necessary for protecting and enhancing the vitality and health of forests. Moreover, transposition of such requirements will also be very burdensome for public administrations, especially in those Member States where small-size foresters are predominant. Secondly, Member States have forest policy frameworks in place to ensure sustainable forest management practices and compliance with the sustainability criteria. The specific frameworks vary from country to country, but all include domestic legislation and a variety of additional requirements that are enshrined in legislation, such as national forest programmes or equivalent and strategies. Member States also use a common set of FOREST EUROPE C&I as a tool to establish 'base-line conditions' and to monitor progress towards specific socioeconomic and environmental goals and other aspects of the sustainable management of forests, including protection and conservation of forests. As these policy frameworks comply with the specific criteria, it would not be necessary to request that at forest unit level.

***Introducing biogenic carbon emission factors in the REDII GHG emission calculation methodology.*** This option would ensure that biogenic $CO_2$ emissions are included in the lifecycle greenhouse gas performance of forest biomass, in addition to supply-chain emissions. This would allow for a full picture of climate impacts from these feedstocks. This is in line with the agreement in the scientific community that accounting of biogenic $CO_2$ emissions needs to be included in order to have a clear picture of the carbon impacts of

[73] ReceBIO follow-up study, 2016

bioenergy[74]. As described in the JRC study on forest bioenergy, biogenic emissions and removals are often not accounted in standard lifecycle analysis (LCA) because it is implicitly assumed that the plant regrowth will compensate for them. However, because of the time lag between emissions and regrowth, it is essential to include biogenic carbon accounting to understand the overall carbon impacts of bioenergy pathways[75]. Nonetheless, Camia et al[76] (2021) also make a clear distinction between using LCA for regulatory purposes (e.g. for benchmarking pathways) and for strategic purposes (e.g. for impact assessment). While the full accounting of biogenic carbon is clearly necessary for proper strategic studies, this is not always the case for regulatory purposes. Indeed, an option to include biogenic carbon accounting within the GHG emission accounting metholodology set out in REDII Annexes V and VI was already considered and discarded in the 2016 Impact Assessment report on bioenergy sustainability, mainly because of the crucial importance of value-choices involved in defining the calculation methodology (i.e., subjectivity in the choice of counterfactuals). In addition, it would pose difficulties linked to verification. Hence, the inclusion of biogenic carbon within the REDII GHG emission accounting methodology would be unfeasible and therefore it is not further analysed in this Impact Assessment.

***Requirements for air pollution related to solid biomass.*** Air pollution is addressed through a number of legal measures at EU level, including Directive 2004/107/EC aimed at reducing concentrations of pollutants in ambient air, Directive 2008/50/EC on ambient air quality, the Large Combustion Plants Directive (2001/80/EC) and Directive (EU) 2016/2284 on National Emission Ceilings. In addition, the Ecodesign directive has set stricter emission requirements for new solid fuel boilers and space heaters. In particular, since 1 January 2020, seasonal space heating emissions of particulate matter shall not be higher than 40 mg/m3 for automatically stoked boilers and not be higher than 60 mg/m3 for manually stoked boilers. The Commission will review these standards in 2021, and revise them if appropriate. Air pollution specifically related to biomass is particularly linked to the stock of old boilers used in particular in households, as well as by the scale of use in certain populated areas. Given the fact that air pollution from biomass is specifically addressed through other EU measures and regulations, it is not considered appropriate to set specific requirements in the context of this policy initiative.

***Application of sustainability requirements to all biomass users (including residential).*** This option aims at avoiding that only part of the biomass consumed in the EU is subject to sustainability rules. However, monitoring compliance for residential heating installation would be particularly challenging, particularly in those Member States that have significant auto-consumption of biomass for heating which is not registered in the commercial markets. Making all bioenergy installations (including residential ones) subject to an EU-wide sustainability scheme would imply disproportionate administrative burden on Member States and citizens to verify the compliance of a high number of small scale/private installations.

***New reporting requirements on forest bioenergy.*** The need for new reporting to improve the monitoring of bioenergy supply and demand was already discussed in the preparation of

[74] https://op.europa.eu/en/publication-detail/-/publication/e6c29d5b-2bef-4ec4-93f5-c3f672af0b47
[75] Agostini et al. (2020). https://link.springer.com/article/10.1007/s11367-019-01654-2
[76] Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719

Clean Energy Package. It is for this reason that the Governance Regulation includes new monitoring requirements for Member States, which need to be transposed at the latest by June 2021. Accordingly, Member States will have to include detailed information on biomass sustainability in their first integrated energy and climate report, to be submitted by 15 March 2023 (see below). This information will feed into the first COM report on the sustainability of biomass due by October 2023, according to Article 35(2)(d) of the Regulation (see box below). In addition, the EU Bioeconomy Monitoring System is strengthening the monitoring of bioenergy supply and demand (see additional info below). Because of these efforts that are already underway, this option is not further assessed.

**Box: reporting requirements on forest bioenergy under the Governance Regulation**

ANNEX IX ADDITIONAL REPORTING OBLIGATIONS
Part 1 Additional reporting obligations in the area of renewable energy

(m) primary supply of solid biomass (in 1 000 m3, except with regard to point (1)(b)(iii), which will be provided in tonnes)
(1) Forest biomass used for energy production (domestic production and import)
(a) Primary biomass from forest used directly for energy production
(i) Where available, branches and tree tops (reporting is voluntary)
(ii) Where applicable, stumps (reporting is voluntary)
(iii) Round wood (split into industrial stem wood and fuelwood)
(b) Where applicable, forest-based industry co-products used directly for energy
(i) Where applicable, bark
(ii) Chips, sawdust and other wood particles
(iii) Where applicable, black liquor and crude tall

(c) Where available, post-consumer wood used directly for energy production
(d) Processed wood-based fuel, produced from feedstocks not accounted under point (1)(a), (b) or (c):
(i) Where applicable, wood charcoal
(ii) Wood pellets and wood briquettes

(2) Where available, agricultural biomass used for energy production (domestic production, import and export)
(a) Energy crops for electricity or heat (including short rotation coppice)
(b) Agricultural crop residues for electricity or heat
(3) Where available, organic waste biomass for energy production (domestic production, import and export)
(a) Organic fraction of industrial waste
(b) Organic fraction of municipal waste
(c) Waste sludges

**Box: JRC EU Bioeconomy Monitoring System**

The EU Bioeconomy Monitoring System was developed as the JRC-led action of the Updated EU Bioeconomy Strategy (COM/2018/673). It addresses the need for a comprehensive monitoring system to measure the environmental, social and economic sustainability of the EU bioeconomy. This monitoring system is a part of the EC Knowledge

Centre for Bioeconomy. The EU Bioeconomy Monitoring system contains indicators that cover the five strategic objectives of the Strategy, which are (1) to Ensure Food and Nutrition Security; (2) to Manage Natural Resources Sustainably; (3) to Reduce dependence on non-renewable unsustainable resources, whether sourced domestically or from abroad; (4) to Mitigate and adapt to climate change; and (5) to Strengthen European competitiveness and create jobs.

Critical indicators include indicators about biomass supply and uses from all primary production systems, as well as the condition and pressures on the ecosystems that produce the biomass. Considerable effort is made by the JRC to collect, harmonise, update and maintain metadata for these indicators. The JRC has a long-term commitment to maintain and continuously improve this monitoring system. Several indicators that are directly related to bioenergy are included in the monitoring system, for the full list, see https://knowledge4policy.ec.europa.eu/visualisation/eu-bioeconomy-monitoring-system-dashboard_en

4. Permitting

Simplifying permitting and administrative procedures was seen by many replies to OPC as a very appropriate measure to facilitate the phasing out of fossil fuels. However, REDII introduced new and substantial requirements on permitting, including clear deadlines for permitting procedures (generally two years) and a single contact point for applicants with clear guidance on procedures. These requirements were designed to alleviate problems with complex and slow national procedures and disproportionate rules, and represent the political compromise reached in REDII. They have not yet been implemented in the Member States (transposition deadline 30 June 2021) and it would be premature to amend them before any evaluation. For these reasons this option has not been pursued.

At the same time, some stakeholders have raised the importance that electrolysers connected to renewable power generation capacity should be considered, and become eligible under the existing permitting processes for renewable energy.

5. Promoting RES through enhanced consumer information – revising the system of Guarantees of Origin (GO) for electricity

The main measure to provide information to consumers on their electricity supply in RED II are the guaranties of origin in Article 19. In the OPC, several respondents asked to improve the existing system by reducing administrative barriers for private companies and by avoiding double counting.

In that context, we looked at revising the current GO measure to further promote RESe in end use sectors e.g. by requiring suppliers to provide closer to real time shares of renewable energy supply or by requiring the issuing of GOs to be linked to the commercial flows with PPAs. These options has been discarded because relevant improvements are already expected through the implementation of the existing provisions of RED II and the Directive on

common rules for the internal market for electricity[77] e.g. with the realtime supply contracts and the requirement to use GO for electricity disclosure. The expected impacts beyond the current baseline are both relatively limited and uncertain.

In addition, implementation issues related to a revision of the GOs would be technically very complex and cause delays in the way forward.

## ANNEX 7: DETAILED ASSESSMENT FOR HEATING AND COOLING

This Annex covers further technical analysis and measures complimenting Chapters 5 and 6. For measures described under Option 2 for to the overall heating and cooling sector (mainly Article 23 of REDII) together with buildings (Article 15) and district heating and cooling further details are included in this Annex.

### Heating and cooling sector

NECP assessment

Under Article 23(1) of REDII, Member States shall endeavour to increase their RES share in FEC for heating and cooling by an indicative 1.3%-point as annual average counting for the periods 2021 to 2025 and 2026 to 2030, starting from the share of renewable energy in the heating and cooling sector in 2020. Article 23(1) also indicates that this increase shall be limited to 1.1% for Member States in which waste heat and cold is not used. If the share of RES in H&C in 2020 is above 60%, the Member States may count any such share as fulfilling the average annual increase (see Art 23 (2b)); if the share is above 50% and up to 60%, the Member States may count any such share as fulfilling half of the average annual increase (see Art 23 (2c)). Member States shall provide any information as to which constraints may be responsible for not meeting the requirements reflecting structural barriers arising from the high share of natural gas or cooling, or from a dispersed settlement structure with low population density.

According to the NECP assessment[78], the renewable energy share in the heating and cooling sector amounted to 21% in 2018 in EU27. The final NECPs of EU 27 anticipate a share of renewable energy in the heating and cooling sector of 23% in 2020 and 33% in 2030[79]. The 33% RES H&C share in 2030 was facilitated by more than 10% decrease in the final energy consumption for H&C projected by Member States from 2020 to 2030 in EU27[80].

The share of renewable energy is above 50% by 2020 in 5 MS (Denmark, Estonia, Finland, Lithuania, and Latvia)[81]. In Sweden, this share is above 60%[82]. Several countries report a low

[77] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU, OJ L 158, 14.6.2019, p. 125–199
[78] Assessment of heating and cooling related chapters of the NECPs
[79] Spain and Latvia did not provide data and were not included in the 33% in 2030.
[80] The final energy consumption (FEC) for heating and cooling represented about 46% of the total final energy consumption in EU-27 calculated on the based on the Shares Tool (Eurostat Statistics) , which reflects national data collection and do not fully report all types of consumption.
[81] Above 50%, Member States has to achieve half of the renewable increase requirement, i.e. 5.5 or 6.5% point per year (Article 23(2)(c) of RED II).

share of RES in the H&C sector and in 3 Member States the share of renewables is below 10%.

As shown in the table below, 13 countries do not comply with the current H&C target, and five countries are expected to comply only partially, i.e. in one of the periods (2020-2025 or 2026-2030), but not in both. Only nine 9 Member States plan to meet their targets.[83]

The table below shows RES share in the H&C sector in 2020, the average annual increase of RES share in H&C by 2025 and 2030. It also indicates whether the Member State takes waste heat and cold into account and whether constraints for not meeting the requirements are provided[84]. Considering all criteria from Article 23 mentioned above, we assessed whether the Member State were screened against these requirements. Member States that are not in line with the requirements are highlighted red, while those in line with the requirements are highlighted green.

*Table 51 - RES share in the heating and cooling sector regarding RED II Art 23 (Member States that are not in line with the requirements from Art 23 are highlighted in red, while those in line with the requirements are highlighted green)*

| **Member state** | **RES-H&C share in 2020 in %[85]** | **Average annual increase of RES share in H&C by 2025** | **Average annual increase of RES share in H&C by 2030** | **Waste heat is counted or not** | **Constraints for not meeting the requirements (see footnote)** |
|---|---|---|---|---|---|
| Belgium | 8.0 | 0.28 | 0.38 | No | No |
| Bulgaria | 31.3 | 1.4 | 0.9 | No | No |
| Czech Republic | 20.7 | 1.04 | 0.96 | No | Yes |
| Denmark | 54.0 | 0.8 | 0.4 | No | No |
| Germany | 16.0 | 0.72 | 0.92 | NA | No |
| Estonia | 55.3 | 0.74 | 0.8 | No | No |
| Ireland | 7.8 | 1.46 | 1.78 | No | No |
| Greece | 30.6 | 1.28 | 1.2 | NA | No |
| Spain | 18.0 | 1.4 | 1.2 | NA | No |
| France | 26.0 | 1.21 | 1.2 | NA | No |
| Croatia | 33.3 | 0.34 | 0.32 | NA | No |

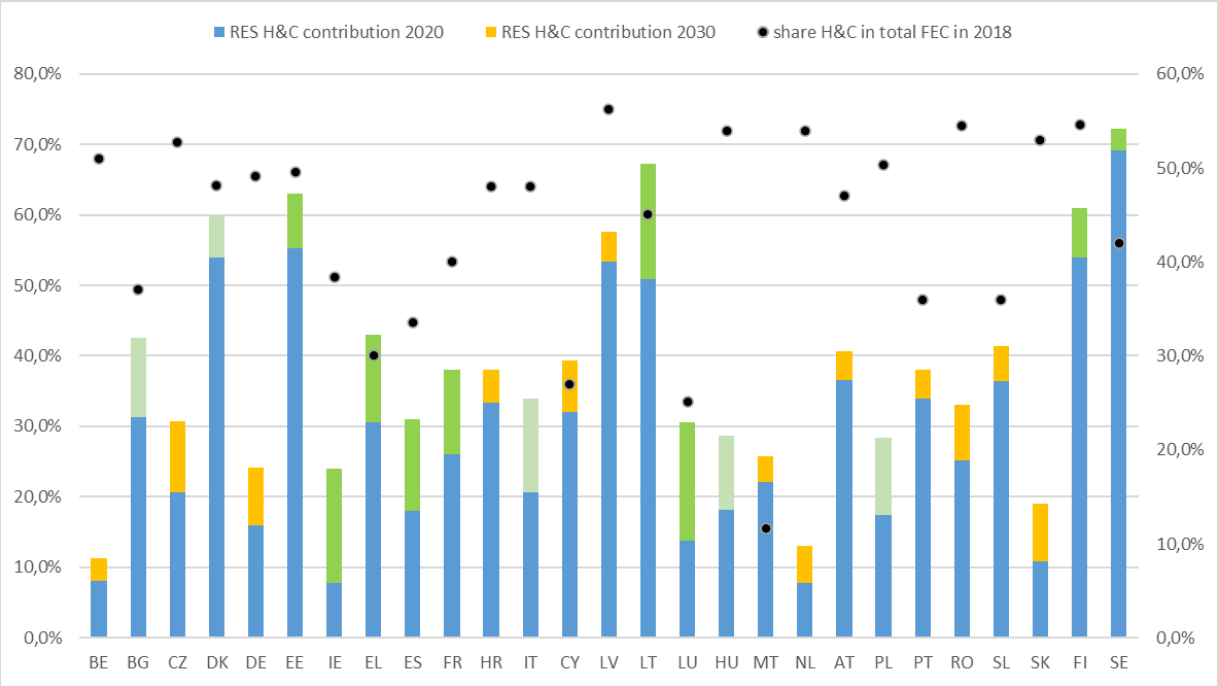
[82] Above 60%, Member States are not subject to the renewable increase requirement (Article 23(2)(b) of RED II).
[83] Estonia, Finland, France, Greece, Ireland, Lithuania, Luxembourg, Spain and Sweden.
[84] For example structural barriers arising from the high share of natural gas or cooling, or from a dispersed settlement structure with low population density.
[85] RES share in final energy consumption for heating and cooling

| Member state | RES-H&C share in 2020 in %[85] | Average annual increase of RES share in H&C by 2025 | Average annual increase of RES share in H&C by 2030 | Waste heat is counted or not | Constraints for not meeting the requirements (see footnote) |
|---|---|---|---|---|---|
| Italy | 20.9 | 0.8 | 1.9 | NA | No |
| Cyprus | 31.9[86] | 0.73 | 0.78 | NA | No |
| Latvia | 53.4 | 0.54 | 0.30 | No | Yes |
| Lithuania | 50.9 | 2.5 | 0.75 | No | No |
| Luxembourg | 13.7 | 1.23 | 2.12 | NA | No |
| Hungary | 18.2 | 0.5 | 1.6 | NA | No |
| Malta | 22 | 0.5 | 0.24 | NA | Yes |
| Netherlands | 8 | 0.5[87] | 0.5 | NA | No |
| Austria | 36.5 | 0.32 | 0.5 | NA | No |
| Poland | 17.4 | 1.06 | 1.14 | NA | No |
| Portugal | 34 | 0.4 | 0.4 | No | Yes |
| Romania | 25.2 | 0.82 | 0.74 | NA | Yes |
| Slovenia | 36.4 | 0.18 | 0.82 | NA | No |
| Slovakia | 12.5 | 0.72 | 0.58 | NA | No |
| Finland | 54.0 | 0.8 | 0.56 | No | No |
| Sweden | 69.2 | 0.56 | 0.04 | Yes | No |

The current share of RES in the H&C sector as well as the ambition to increase it over the period 2020-2030 varies considerably between the Member States, as illustrated by the figure below.

[86] Interpolated value (the original value was given for 2021, and it amounts to 32.6%)
[87] Calculated for the period 2021 to 2030 (data for 2025 is not provided)

*Figure 79 - Share of RES in H&C in all MS in 2020 & in 2030 + share of H&C in Final Energy Consumption; Source: Trinomics based on JRC's assessment of NECPs*




*In the figure above, the blue bars shows the large variations between MS regarding their share of renewables as expected for 2020. In 2020, 6 MS were expected to have a share of RES in H&C above 50%, while 3 MS would have a share below 10%. In 2030, only 9 Member States meet the target of 1.3%-point annual increase of renewables in the H&C sector of Article 23(4) of RED II (dark green in Figure above). 4 additional Member States meet partially the target (light green in Figure above).Specific measures for the overall heating and cooling sector*

Options for sector-specific measures to increase renewable energy in the heating and cooling sector (RES-H&C)

**Option 2: Menu of voluntary measures**

**Option 2a)** Add/clarify measures that Member States can use to implement the target (menu of measures Member States can choose from/obligation to implement at least 2 measures)

Option 2a): Add/clarify measures to the list in Article 23(4) that Member States can use to implement the target (menu of measures Member States can choose from/obligation to implement at least 2 measures)

This option in part clarifies the current high-level provisions and in part includes strengthening of the existing measures by also including new aspects.

*Possible sector-specific measures*

- **Option 2a)-A1**: Capacity building for national/local authorities to plan/implement renewable projects and infrastructures for heat planning requirements at local/regional level;

- **Option 2a)-A2**: Risk mitigation framework to reduce cost of capital for renewable heat projects;
- **Option 2a)-A3**: Heat purchase agreements for corporate and collective small consumers;
- **Option 2a)-A4**: Planned replacement schemes of fossil heating systems - fossil phase-out schemes with milestones;
- **Option 2a)-A5**: Update of the qualification and certification requirements of installers (article 18 and annex VI), and obligation on technology providers and vendors, that trained and qualified installers are available in sufficient numbers to service the required growth in renewable heating and cooling installations in buildings and industry.

As indicated in Section 6.2 these measures could be combined with the target options.

***Analysis of impacts of sector specific measures for the overall HC sector (relevant also for district heating and cooling and buildings)***

***<u>Options 2a)-A1</u>: Capacity building for national/local authorities to plan/implement renewable projects and infrastructures, national and local heat planning***

*Effectiveness*

Capacity building is considered a cost effective way to support the decarbonisation of the heating and cooling sector. Capacity building is especially important to Capacity building in heating and cooling, including heat planning, has been supported by a number of Horizon 2020. However, wide scale replication and diffusion is more effective if the results could be consistently conveyed via an EU framework across all Member States. Coordinated infrastructure planning with more involvement of local and regional authorities could result in important economic savings and avoid issues of mis-planning, mis-communication, mis-information and lack of understanding of the local particularities, needs and opportunities resulting in inefficiencies. The costs related to administration, coordination and communication are not expected to be significant compared to the savings of avoiding inefficient planning.

*Administrative burden*

Planning of renewable and waste H&C deployment projects and infrastructure in heating and cooling should ideally be at the core of the NECP section on the deployment of renewable in the H&C sector. Given the high dependency of the different energy infrastructures (in the frame of energy system integration, moving e.g. partially from gas network to electricity and/or DHC). The LTRS should also have addressed, at least partially, the issue of planning, as the deployment of renewable heating systems and the increase of energy efficiency in buildings should go hand in hand. Planning the deployment, reinforcement, extension or dismantling of existing infrastructure, need to consider the expected evolution of heat demand (which influences the alternatives), and the existing alternatives that can replace fossil fuels, including the potential for low carbon liquids and gases (from biological origin or not). Therefore, the planning process would encompass the whole decarbonisation of the H&C sector. Most of the MS have already started to plan, or at least to define planning the

deployment of renewables in H&C, but their progress depends on their global commitment and the set of policy measures they foresee in the frame of their NECPs. For some, planning would be a question of progressively mainstreaming H&C infrastructure considerations in other policy areas (e.g. urban policy), to ensure full coverage of the H&C concerns. For others, planning would be required as a kind of overarching framework, and would therefore encompass the complete process of H&C decarbonisation, including the Comprehensive Assessment (article 14 EED). Such planning could also be seen as a part of the LTRS, where a more dedicated focus on supply should be mainstreamed, highlighting the importance to address the deployment of all heat market and related infrastructure (gas, liquid, electricity, and heat).

For those MS starting from the beginning, administrative overburden is probably the higher risk that could jeopardise the whole planning process, due to the lack of human and financial resources, and the need to take into account local parameters. A balance has to be found between the details and the efficiency. Therefore, guidance would be useful to support MS planning in an effective way. A recent study[88] for the EC on the competitiveness of the H&C industry and services finds that easing administrative costs and barriers via better alignment of procedures and requirements (e.g. technical requirements, certification and licencing) would make it substantially easier for renewables to enter markets and become more competitive.

For those MS having a set up a clear vision on the way to decarbonise the H&C, and especially to deploy renewables, planning would then be a kind of reminder of the important and integrated issues to address.

Key steps to consider in the planning of deployment of renewable heat and associated infrastructure include[89]:

- **Developing strategic H&C plans** – this is a first step and needs to consider the local context, resource availability, existing infrastructure, socio-economic conditions etc. The three-step approach described in the textbox on Decarb City Pipes 2050 project could be a suitable template for H&C plan development in cities.
- **Stakeholder engagement** – the type of stakeholders and extent of their engagement will, to an extent, depend on the H&C plans developed.
- **Assessing and mapping HC demand and energy resources** – this step would expand on the initial information considered for planning. In the case of the H&C sector the location of the demand and supply is of critical importance in order to enable connecting them to one another. The planning should also take into account other energy sectors in the analyses to maximise synergies and ensure energy system integration where possible.
- **Integrating energy resources in the existing and new infrastructure to match the demand** – future demand can be deduced through measurements of

[88] Still to reference

[89] Bertelsen, N., Mathiesen, B. V., Djørup, S. R., Schneider, N. C. A., Paardekooper, S., Sánchez García, L., Thellufsen, J. Z., Kapetanakis, J., Angelino, L., & Kiruja, J. (2021). Integrating low temperature renewables in district energy systems: Guidelines for policy makers. International Renewable Energy Agency.

actual demand in buildings, bottom-up modelling for building consumption and top-down modelling of heat demands.

- **Assess the required investments, operational and fuel costs, including all technical challenges** – for many heating technologies upfront investments and high capex costs constitute a barrier for competing with current, fossil-based technologies. Thus, appropriate instruments to lower this barriers and promote uptake are crucial. A level-playing field for operational and fuel costs, by, among others, eliminating subsidies or other fiscal incentives for fossil-based fuels is important.
- **Enabling regulatory conditions, financing, and business models to deploy –** this aspect is closely linked to the point above. Government authorities need to establish financial and regulatory measures to ensure that the benefits of renewable heating systems are captured by the established pricing regimes.

As explained above, these steps are already tackled by the MS, to varying extents, meaning there is no one single approach to assess the administrative costs related to their implementation.

National authorities will be strongly involved, but local authorities (municipalities, cities, or regions) will also need to progressively commit and engage in the process of planning renewable H&C deployment projects and infrastructure. In several MS, major cities have already started and provide good examples on the best planning approach, such as illustrated in the textbox on Denmark.

**Experience with heat planning[90]**

A report prepared by the Danish Energy Agency (2019) aims at providing inspiration on municipal heat planning based on Danish experiences and delivers input to a common heat planning methodology for municipalities in Baden-Württemberg. Such report can provide useful guidance for other municipalities in their heat planning.

Danish heat planning was kick started in the late 1970's as a response to the two oil crises in 1973 and 1979, which had huge implications for the Danish economy. The reason for commencing heat planning in Baden-Württemberg is even more serious, namely the wide recognition of the global climate crisis. Though the backdrop for planning is different, this report shows that a lot of the experience from Denmark have high relevance for Baden-Württemberg. In addressing the Danish experience with heat planning, the region has put special emphasis on the learnings from the beginning of 1980's when the framework for Danish heat planning was created.

In order to meet its climate and energy targets Baden-Württemberg has a strong focus on energy efficiency improvements in housing and green heating. This entails an expansion of district heating through municipal heat planning with a particular focus on supply from fuel free energy sources.

The German region recently required its 103 cities of more than 20 000 inhabitants to develop a vision for their CO2-neutral heat supply 2050.91

[90] Experience with heat planning in Denmark, input for developing a heat planning in Baden Württemberg, Danish Energy Agency (https://www.ea-energianalyse.dk/en/front-page/), 2019

While the total population of the Baden-Württemberg is approx. 11 million people, the 103 largest cities hold a population of approx. 5,5 million people, that is roughly the same number of inhabitants as in Denmark. Therefore, planning at city level requires guidance and commitment at regional or national levels.

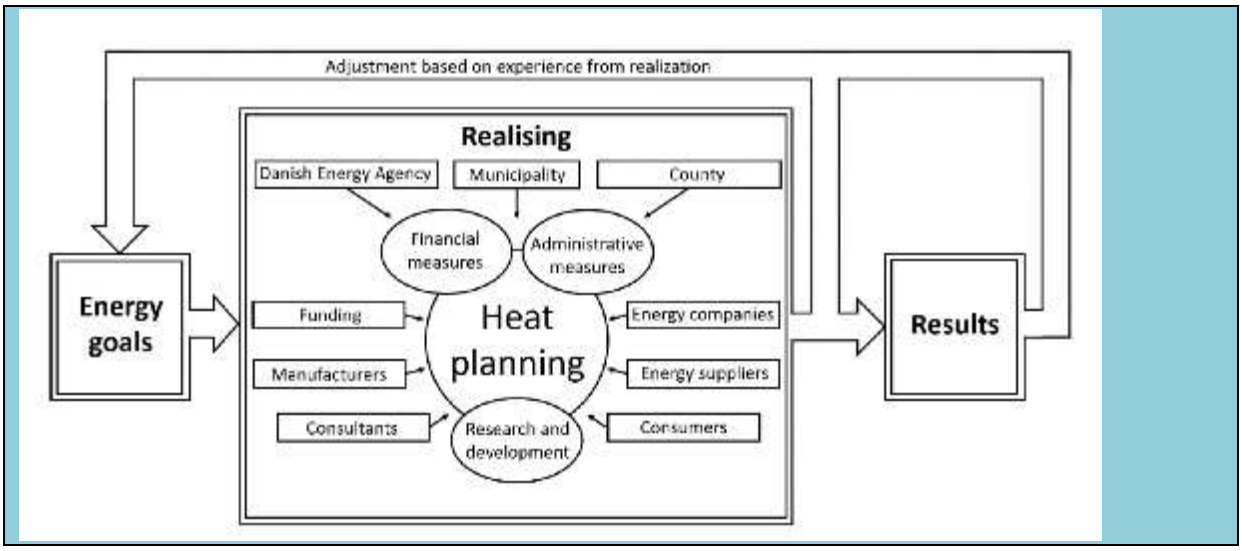
Despite its long experience in district heating (over 40 years), the Danish heat planning was implemented over a relatively short time span. The first heat supply act was introduced in 1979 - before that there was no fixed framework for heat planning- and by the mid 1980's almost all Danish municipalities (there were about 300 at the time) had developed heat plans. The main objective of the heat planning was to determine, which areas in the municipality should be supplied with district heating or natural gas, and which areas were still supposed to use individual heat sources such as oil boilers, biomass boilers or electric heating. All these considerations are still valid, although they could be expanded with the new fuels and technologies. A key selection parameter in the heat planning was the energy density of the different areas of a municipality. The principal approach was that most densely populated areas would usually be supplied with district heating, less densely populated areas with natural gas and the more sparsely areas with individual heating.

The heat planning also provided directions on how district heating should be supplied. This in turn influenced the location of district heating systems in a way where cities with large amounts of surplus heat from power generation or industries would typically expand district heating to less densely populated areas that would otherwise have been supplied with natural gas.

Since the late 1980's, heat planning in Denmark has developed on a more ad hoc based approach. During the 1990's a lot of mainly smaller cities, which previously had not had collective heat supply, developed district heating systems based on combined heat and power plants, mainly gas-fired, and in the last 10 years quite a few areas, which were originally designated for gas boilers, have been converted to district heating. The conversion contributed to the increasing share of district heating of total heat supply from around 46% to around 50% in the past decade. Since 2011, the number of district heating installation in both new and existing buildings has increased by 9%. Whereas the heat planning that took place in the early 1980's aimed at reducing oil dependency, the later steps of heat planning have focused on reducing the environmental impacts, particularly the CO2 footprint, of heat supply.

The following figure illustrates the main actors of the energy system that should be involved in heat planning.

[91] https://decarbcitypipes2050.eu/2021/02/10/heat-planning-baden-wurttemberg-takes-the-bull-by-the-horns/




Among the main lessons to be used for the Baden-Württenberg:

1) Heat planning needs to be locally anchored
2) Capacity building and knowledge sharing was key to successful heat planning
3) Multilateral municipal coordination groups were key to human capacity building
4) Developing common planning assumptions improved the quality of the planning process
5) Educational programs linked to the concrete planning contributed to human capacity building
6) Policies need to ensure that solutions that are desirable from a social perspective are also advantageous from a consumer viewpoint
7) District heating projects need to prove that they benefit society as a whole
8) Requirements for mandatory connection has been a powerful but debated tool in Danish heat planning
9) Both normative and financial policies were applied to incentivize green heating
10) Political attendance at the highest level ensures resources and commitment to heat planning
11) Public involvement was key to get commitment to the plans among citizens
12) New district heating systems and extension of existing systems were driven by existing district heating companies and cooperatives with strong local support.

***Option 2a)-A2**: Risk mitigation framework to reduce cost of capital for renewable heat projects*

*Risk mitigation for large heat generation and infrastructure projects:*

**Risk mitigation framework to reduce cost of capital for renewable heat projects**

Deploying renewable heating and cooling projects often entails large upfront investments for small and large investors alike.

In the case of large heating and cooling projects, for example geothermal, solar thermal or innovative waste based technologies in district heating and cooling systems and for the development of large generation and network capacities, the upfront investment represents a high risk for one single investor. This is due to the volume of the investment as uncertainties in societal, technical, administrative, political, environmental areas and in markets could lead to a failure of the whole project. Risk mitigation measures and sharing of the volumes at risk

(called risk volumes) are key for investors. Therefore, the different types of risk exposure for renewable heating and cooling projects are outlined and measures suggested that reduce these risks and the risk volume.

In the case of small investment projects, households and small enterprises do not often have sufficient expertise and financial resources to make the necessary upfront investment and tackle the technical complexities, which also represents risks for small investors, but also for financial institutions, which are reluctant to support small projects with high transaction costs.

This option aims to address both large project risks and the risks for both consumers and financial institutions of small, diverse and diffuse investment in new renewable heating systems.

– *Risk mitigation framework for large renewable heat supply projects.*

The life cycle of these projects requires a long-term planning security. This means a long-term strategy ensuring the feed-in or demand for renewable heat, including forward looking perspectives such as a target for the RES-share in HC, measures to stimulate investment and demand, identification of cost-effective sites and standards for impact assessments. The availability of one-contact point could facilitate administrative procedures and provide information on potential sites (groundwater and geothermal sources) and thus reduce administrative burdens and related barriers or risks.

Addition risks can characterise specific projects in specific phases, such exploration and drilling in geothermal or the planning and construction of heat infrastructures and securing public acceptance is also a risk.

The benefit of a risk mitigation framework directly manifest in reduced cost of capital, energy costs, technological developments as well as scale effects in production and installations – as observed in the wind and solar power – and thus could contribute to declining unit costs and increase profitability of the project. Financial investment support for innovative and sustainable technologies (R&D support) might have a dampening effect on costs as well as on the volume risk. Market risks, such as price and sales risks, are addressed by Art. 4 RED II for renewable electricity while heating is not mentioned.

Besides risk reducing measures, risk sharing through special financing facilities such as a special programme for geothermal projects in the framework of InvestEU (former EFSI), or public financing at national levels.

The risk mitigation framework could have different design elements, including one-stop-shop, institutional project assistance and pre-selection of sites, etc.

Examples from Member States

**(1) RES2 in Italy**

Italy has outlined the contribution of geothermal energy in its renewable energy targets.[92] It has drafted a provision of support (RES2) for innovative technology, which has significant potential for innovations and a considerable exploitable potential (energy). This includes adhoc instruments for new plants based on innovative technologies and for example measures

[92] NECP Italy, https://ec.europa.eu/energy/sites/default/files/documents/it_final_necp_main_en.pdf, section 2.1.2

such as auctions, register mechanisms.[93] Italy is in charge of the Strategic Priorities of the SET Plan regarding the European leadership in the development of RES, in particular of the geothermal sector.[94] However, it does not outline how to address the high risks associated with high upfront investments.

**(2) SAF environment Fund in France and other measures for geothermal energy**

The Auxiliary Finance Company (SAF) guarantees funds to covers the **risk of geothermal energy**. Two types of guarantees are possible: short-term, for the success of the first wells drilled and long-term, for the sustainability of the resource and risks of total or partial drying up and damage to the installations over a period of 20 years of operation.[95]

Further investment in geothermal energy, geothermal district heating and cooling systems, and heat storage solutions using geothermal energy, is supported through the Heat Fund. In addition, to mitigate drilling and exploration risks, France enables the participation by the Heat Fund in funding regional mapping for Geothermal installations of Minimal Importance (GMI), and where necessary in funding support for decision-making on the economic profitability of surface geothermal resources.

Beyond financial support, local coordination structures will be implemented to coordinate the activities in the region and exchange directly with ADEME. Further, to facilitate drilling and exploration of geothermal energy from an administrative perspective, the Mining Code will be modified with respect to explicitly mentioning the generation of heating and cooling through geothermal energy as activity[96].

**(3) Renewable Energies Heat Act in Germany/Market incentive programme**

. While at the consumption side, no incentives for using (large) geothermal heat is provided, investors of geothermal generation facilities are directly addressed through the market incentive programme. It offers financial support (grant) for drilling and installations as well as for the related network of large geothermal projects through the KfW programme (state bank) as part of the market incentive programme, which is anchored in the Renewable Heat Act.[97]

- *Risk mitigation framework for small renewable heat supply projects.*

This option would ensure that projects aggregation and de-risking is extended to small heating system replacement projects and these are addressed together with other component of building refurbishment on an equal footing. The model would follow the one established in the Energy Efficiency Financial Institution Group (EEFIG[98]) as the findings of this projects are equally relevant for small renewable heating and cooling project investments.

[93] NECP Italy, p. 114 and 147
[94] NECP Italy, p. 231
[95] NECP France, https://ec.europa.eu/energy/sites/default/files/documents/fr_final_necp_main_en.pdf
[96] Law No 2018-727 of 10 August 2018 has empowered the government to take measures (through the uses of ordinances) to reform the provisions of the Mining Code in relation to the granting and extension of titles for the exploration and operation of geothermal energy. The objective of this scheme is to simplify the applicable rules in order to improve the development of renewable energy activities.
[97] NECP Germany, https://ec.europa.eu/energy/sites/default/files/documents/de_final_necp_main_en.pdf

Although the majority of energy financing was focusing on large electricity related renewable energy generating assets until the last decade, obtaining adequate financing for small renewable projects still remains a challenge.[99]

Therefore, increasing access to long-term debt and renewable installation finance through adequate instruments is needed, and should be bundled with energy efficiency instruments. The EEFIG should be explicitly extended to RES H&C.

Such instruments could allow operational renewable energy projects to finance into long-term debt and increase the financial leverage by "discounting" the future cash flows, possibly from a heat purchase agreement. These cash flows (from heat purchase agreements) could serve as collateral, reducing the amount of equity needed and improving financing terms, for increasing the capacity to invest, addressing more holistically the building renovation. While such instruments would focus on financing, their goal would be to increase new investments in one building when all energy efficiency and renewable are not addressed in one shot, especially when the new investments would have a longer payback time.

According to the EEFIG, evidence from the market strongly suggests that simply providing capital does not necessarily lead to successful deployment of that capital. It is necessary to consider the factors that drive demand for financed energy efficiency and put in place mechanisms to help drive demand such as technical assistance and marketing. The same applies for small-scale renewable.

All energy efficiency and renewable investments, whatever their size or nature, face various types of risk such as performance risk, quality or market risks. Addressing appropriately the categories of risks is key to define the approach to risk mitigation and financing. Databases for heating and cooling investments (RES and EE) could support de-risking those investments (cf. textbox to illustrate such DB).

**De-risking examples**

The De-risking Energy Efficiency Platform (DEEP[100]) was developed by the EEFIG De-risking Project consortium and launched in the end of 2016 in close coordination with the Commission's "Clean Energy for All Europeans" package. DEEP is an open-source database for energy efficiency investments performance monitoring and benchmarking, based on evidence from implemented projects. The main objective of the DEEP is to improve the understanding of the real risks (especially performance risks) and benefits of energy efficiency investments based on market evidence. At launch the database included more than 7,800 energy efficiency projects in buildings and industry from 25 data providers. DEEP provides anonymized historical data structured along major project characteristics, (geography, energy efficiency measures, verification status, industry / type of building, multiple benefits, etc.). It provides insight on financial performance indicators such as payback and discounted avoidance

cost. Financial institutions can use this evidence in market assessment, performance risks calculation and to benchmark their own individual projects or portfolios against user-selected sub-sets of the projects in DEEP.

Setting up risk-mitigation and instruments are no-regret measures and should be adopted in a structured way to frame the decarbonisation of the whole heating and cooling sector, building on existing tools and initiatives. De-risking instruments is decreasing the cost of capital, and therefore would reduce the cost of renewable H&C technologies, increasing their attractiveness to all. These instruments may have a slightly positive impact, allowing more consumers to use renewable H&C.

*Effectiveness*

The option would be effective in reducing costs of capital, reduce barriers to financing and increase access to and the number of renewable heating and cooling projects. It would thus contribute to the objectives of increased renewable deployment in heating and cooling and to the overall renewable share increase in line with the CTP.

*Administrative burden*

The option could partially build on and further develop the already existing framework under the REDII, which covers mainly renewable electricity. The setting up of risk mitigation framework would represent some additional burden for Member States. However, such framework could use synergies with several other initiatives under the Green Deal, which could be extended to cover large and small renewable heating and cooling projects. One of these synergies would be with the many instruments available for building renovation and under the EEFIG. These already cover - although not in a consistent manner - renewable energy and could be extended to renewable heating and cooling projects, including the mechanisms available for aggregation of small projects, de-risking, and technical assistance.

*Option 2a)-A3: Heat purchase agreements for corporate and collective small consumers*

*Effectiveness*

A power purchase agreement (PPAs) is a long-term electricity supply agreement between an installation operator (seller) and an electricity customer (buyer). The agreements are generally signed for a period of up to 10 years, though shorter-term PPAs are also possible. Heat purchase agreements, as the name implies, mirror PPAs but focus on the selling and buying of heat. The generator of the renewable heat receives a fixed price per unit of energy (e.g. joule), meaning that it can expect fixed returns on its investment and offer the bank the certainty it requires for the loans. The high-demand customer can therefore ensure that its renewable energy supply comes either directly from a specific plant, or from a green portfolio, at a fixed price for the duration of the agreement. The proof of the green quality and origin of the energy supply is provided by the guarantees of origin (GO) of the energy/heat-generating plants.

Although supplies of heat (or cooling) are similar in many respects to other utility type supplies, in heat networks there is a key difference, namely that the customer's use of the

energy supplied has a significant effect on the overall operational efficiency of the network. This is reflected in how heat purchase agreements and their tariffs are structured.[101] The company learning costs and associated administrative burden costs related to contract drafting, legal implementation etc. are expected to be outweighed by the financial certainty for suppliers and provision certainty for that such agreements bring. These in turn, are expected to support the mainstreaming of heat markets.

*Administrative burden*

The option enables companies and collectives of consumers to have access to renewable heating and cooling at lower costs. The administrative burden is limited and is compensated with the benefits in terms of empowerment and lower purchase prices.

*Option 2a)-A4: Planned heating system replacement schemes:*

This options aims to give certainty and allow preparation and high-quality replacement of current old and obsolete fossil heating systems by renewable and carbon neutral ones with pre-defined schedules and gradually. The option would empower Member States to implement modernisation coupled with fossil phase out and define the design and milestones according to the specific circumstances (e.g. age, composition) of their heating stocks, while ensuring coordination with their national building renovation strategies.

Over half of the EU individual oil and gas boiler stock is older or in the second half of its technical lifetime (lifetime 20 years). These will have to be changed in the period until 2030 and replaced with renewable and carbon-neutral solutions to avoid carbon lock-in. Since renewable and carbon-neutral heating technologies are already available and their levelised cost of heat is not significantly higher, or, depending on the specific function and technology, is lower than that of new fossil systems, the replacement does not lead to additional investment compared to what will anyway have to be invested. It is rather a prudent spending for heating systems that anyway need to be replaced, while ensuring that investment is in future proof technologies and carbon lock-in is avoided.

Planned replacement programmes could be designed in many different ways: such as fossil phase-out according to certain schedules or by trigger points (new construction, major renovation, heating system inspection/change, renting, etc.) or for certain building types (public, commercial, etc.). It can include national scrappage schemes (e.g. for boilers beyond their lifetime or at boiler replacement trigger points.

Around half of the EU heating stock will need to be changed in the next 5-8 years as indicated in the figure below. Further disaggregation for a selected number of countries (DE, FR, SP, PL, RO, FI) is found further below under the buildings section.

Member States will have the freedom to design and implement measures that ensure an orderly replacement. Fossil phase-out with milestones gives the most freedom for MS as regards the choice of implementation and requires them to plan and ensure implementation of gradual replacement of fossil heating systems by 2050 with defined milestones in 2030. It

[101] Scottish Futures Trust (2018) Guidance on the development of Heat Supply Agreements for District Heating schemes. Available at: https://www.districtheatingscotland.com/wp-content/uploads/2018/02/HSA-guidance-final-Feb-18.pdf

also leaves them free to put in place boiler replacement/scrappage schemes and set requirements at national level for technology providers.

*Effectiveness*

Heating appliances usually last 20 years so it is important to avoid the installation of old, inefficient and fossil heating systems in buildings by 2030 the latest, as this can lead to a carbon lock-in and stranded assets. Thus, requiring Member States to plan heating system replacement would be an effective way to increase the decarbonisation of the heating sector and to 'future-proof' it. In addition, a number of cities/regions have already announced plans to phase out fossil fuel based heating[102], or certain types such as oil based[103], so this measure would fit with existing national policies. Decreasing fossil fuels in heating systems will have beneficial environmental affects, although if this is through increased use of biomass, the effect on air quality would need to be assessed. The mandatory minimum energy performance standards proposed in the Renovation Wave Communication as part of the revision of the Energy Performance of Buildings Directive could also facilitate the gradual phase out heating systems based on fossil fuels.

The proposed options on targets for heating and cooling (see also options on buildings) combined with the options proposed for supporting measures (planned heating systems replacement) would ensure that the upcoming replacement cycle is well-used to trigger a switch from fossil fuels to renewables and other carbon-neutral solutions, and prevent the installation of new fossil appliances, which due to the long lifetime of these assets, would result in carbon lock-in..

The transition from fossil based heating to renewable ones would not entail large costs additional to what anyway will have to be incurred as planned replacement would be staged replacing those systems that are beyond or at the end of their lifetime, thus – given that heating is essential – when investment in new system has to occur anyway. Planned replacement would by design target those systems that need to be changed in any case and would follow the natural replacement cycle of heating (and cooling stocks (See Annex XX showing the age of heating stock in selected countries). In addition, the cost of a new renewable heating system and the related levelised cost of heat (LCOH) is often at par or lower than that of competing fossil-based system. LCOH for a selected number of countries (DE, FR, SP, PL, RO, IT and FI) is shown in previous sections.

The proposed risk mitigation option is considered necessary and effective to give the correct signals to the market and help small innovative projects to leverage funding[104].

*Administrative burden*

Planned replacement schemes of heating appliances to facilitate fossil phase-out can be implemented through several instruments such as support schemes, fiscal incentives, building requirements for new buildings and deep renovation, or via banning purchase of determined products (heating appliances). Minimum administrative requirements foreseeable would include:

[102] Vienna
[103] Germany
[104] Energy Efficiency Financial Institution Group (EEFIG) report: https://www.bpie.eu/wp-content/uploads/2017/06/EEFIG_Underwriting_Toolkit_June_2017.pdf

**Data collection**. In order to understand the extent of the necessary replacements and to monitor the implementation of any phase-out scheme reliable data is a pre-requisite. Thus, lack of reliable information is often a barrier as setting up data collecting procedures might require significant administrative costs. For example, an evaluation of the effects of the Baden-Württemberg Renewable Heating Act found that data sources were inconsistent. Data on the number of heating system exchanges reported to the Statistical Office of the State of Baden-Württemberg including that reported by chimney sweeps was different from the market statistics of boiler manufacturers. One of the reasons for this was attributed to authorities not having enough time and resources to ensure rapid data processing.[105]

**Monitoring, reporting and enforcement costs.** To ensure that the phase-out programmes are proceeding accordingly and that the results are consistent with targets set for e.g. 2030 or 2050, monitoring and reporting procedures should be set up periodically. The time-intervals for monitoring should strive to find a balance between achieving sufficient information for assessing the programme and excessive administrative burden. For example, in the case of Baden-Württemberg the number of energy audits has increased significantly since 2015 – the year in which the Renewable Heating Act was amended introducing the renovation roadmap[106] .

**Awareness raising campaigns.** Are important to adequately communicate to the citizens the programme being implemented, the reasons for it, expected outcomes etc. Benefits include increased awareness of citizens, increased probability for public acceptance and support, stimulating capacity building, generating conditions for an efficient citizen participation process and the involvement of stakeholders. As such replacement schemes could be misunderstood by the concerned parties[107], a very clear communication is of paramount importance. Campaigning costs could be as high as 400, 000 EUR/yr.[108] Costs to consider include:

- Market research expenses
- Expenses related to the design of communication tools and brand
- Publication expenses
- Website maintenance costs
- Direct communication and meetings
- Training of staff
- Organisation of press conferences and events

**Multi-level coordination.** As already mentioned, these instruments would require additional planning efforts, to tackle all local/regional/national influencing factors and constraints, and therefore increasing development costs, for national involved parties (national authorities and administrations, but also building professionals, such as architects, planners, designers and construction workers, and local authorities).

**Importance of local actors engagement**. When phasing out fossil systems, it is of paramount to have a clear vision on the long term low-carbon/renewable alternatives (to

[105] Pehnt, M. et al. (2019) Evaluating the renewable heating and efficiency obligation for existing buildings – insights into the mechanisms of mandatory building requirements

[106] https://um.baden-wuerttemberg.de/index.php?id=8110

[107] As it was the case in Belgium, end of 2017, when the 2050 Energy Pact fixed the objective to stop selling heating oil appliances after 2035, there was a large confusion and string reaction by the stakeholders, and even social actors. https://www.chauffagistes-belgique.be/pacte-energetique-implications.htm & https://heatingexpertise.be/fr/2019/07/10/vers-la-fin-du-chauffage-au-mazout-en-belgique/

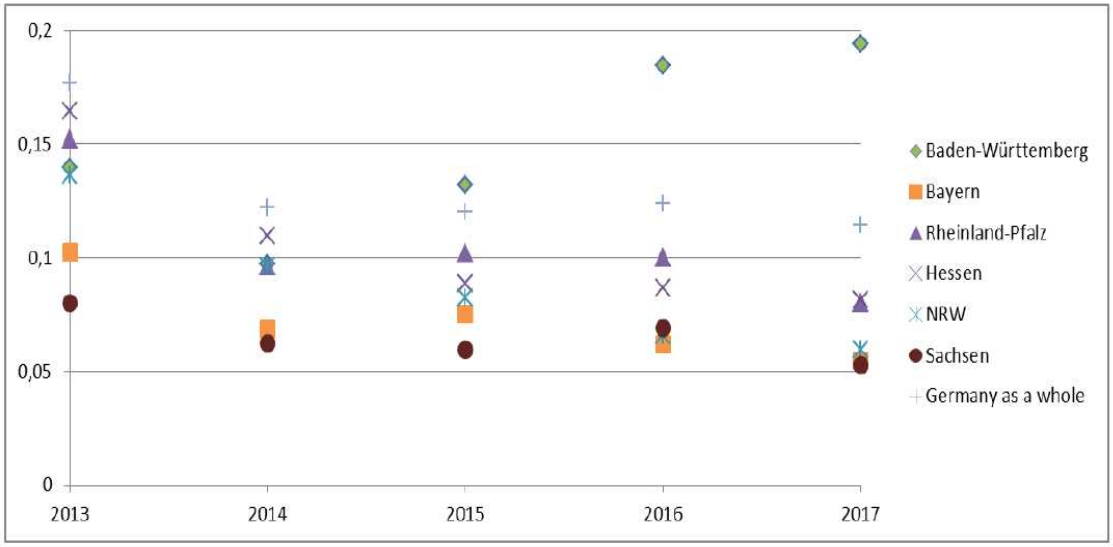
[108] Niches. Innovative Demand Management Strategies: City-wide Campaigns. Available at: http://www.rupprecht-consult.eu/uploads/tx_rupprecht/14_City_wide_campaigns.pdf

determine by what a fossil-based system should be replaced). The other case of the Aosta Valley region illustrates how important it is to consider local parameters, when assessing the demand side (consumption profiles), and mainly the supply side (the most attractive renewable alternative is wood-based fuel). This requires engaging decision bodies at regional or even local levels to plan correctly the deployment of renewable. It is hardly recommended to start at these levels (as was also the case for Baden-Württemberg).

As explained above, depending on the national situation, some of these steps are already tackled in the implementation of the LTRS, and would only require a marginal additional effort, while for others it would require to deploy a new vision.

The figure below shows that the number of energy audits in Baden Württemberg has increased since 2014 and is the highest among several German federal states. The high number of audits can be linked to the updated made in 2015 to the Renewable Heating Act Baden-Württemberg. There is a correlation between the success of a replacement-schemes and associated monitoring and energy audits. The administrative burden could be limited to a simple scheme driven from the national level, and increased in complexity and involvement of local actors.

*Figure 80 - Evolution of the number of funded energy audits per capita in different German federal states*




**District heating and cooling**

*Technical assessment*

The GHG reduction impact would be significant as demonstrated by cases, where DHC is the main Green Deal conform instrument to decarbonise heating in entire cities. The options would significantly contribute to air quality and particulate emission reduction, improving health conditions in cities. Case studies[109] on efficient, renewable-based and smart DHC systems show $CO_2$ emissions below 100 gram $CO_2$/kWh[110]. Examples are: the Gram solar thermal DH system in Denmark (30 kg $CO_2$MWh); the Paris Saclay DHC system in France

[109] Efficient district heating and cooling systems in the EU, Tilia GmbH, 2016
[110] Efficient district heating and cooling systems in the EU. Case studies analysis, replicable success factors and potential policy implications. Tilia GmbH for the JRC, 2016.

(below 100 kg $CO_2$/MWh), which is based above 50% on renewables, the Ecoenergies Barcelona DHC system in Spain (94,9 kg/MWh for the district heating part and 0 kg $CO_2$/MWh for the district cooling part based on surplus cold and renewables), the Stockhom DHC system in Sweden (0,136 kg $CO_2$/MWh for heating and 0 kg $CO_2$/MWh for cooling), the Tartu DHC system in Estonia (0,102 kg $CO_2$/MWh for heating and 0 kg $CO_2$/MWh for cooling), and the HafenCity DH system in Germany (75 kg $CO_2$/MWh). One of reasons for investing in these systems was to improve air quality, in addition to ensure stable low prices of heat – these are two important reasons for consumer acceptance.

Need to upgrade existing DHC[111]

**Upgrade DH**
The Upgrade DH project aims to improve the performance of district heating networks in Europe by supporting selected demonstration cases for upgrading, which can be replicated. The project aims at initiating the DH upgrading process (retrofitting approaches); increasing the share of waste/residual heat (currently 7 % in the demo cases) by more than 6 % and the share of renewable heat (currently 28 % in the demo cases) by more than 20 % in eight demo cases and beyond; replicating the proposed upgrading solutions across Europe; developing regional / national action plans for the retrofitting of district heating networks by including the results of the retrofitting approaches.

The Upgrade DH project supports the upgrading and retrofitting process of DH systems in different climate regions of Europe, covering various countries: Bosnia-Herzegovina, Croatia, Denmark, Germany, Italy, Lithuania, Poland, and The Netherlands.[112] On these 8 cases, the following 3 cases explicitly include the use of additional renewables: Bosnia-Herzegovina plans the integration of solar thermal collectors; Denmark intends to convert the CHP to biomass; the Netherlands intends the installation of a second 16MW biomass boiler.

However, in most cases, the focus of the upgrading was to increase the relative share of renewables in the heat production as well as to improve the use of the available resources, and to optimize the management of the network.

In some cases, by reducing the environmental effect, especially emissions of the local pollutants, the health of the local population increases, which is one of the main social benefits of such a project, but also the fact that public opinion towards DH would increase due to such projects promoting efficiency and increasing the share of renewables in DH production.

[111] https://www.upgrade-dh.eu/en/about-upgrade-dh/
[112] https://www.upgrade-dh.eu/images/Publications%20and%20Reports/UpgradeDH%20D5.5.pdf

*Cost-effectiveness*

*A recent analysis of the cost-effectiveness of district heating compared to individual heating solutions under conditions based on the Danish system including the Danish taxes and tariffs shows that new district heating is highly competitive vis-à-vis individual heating technologies. Looking at a heat demand of 13 800 kWh/year corresponding to an energy renovated building and considering DH produced with a wood chip boiler or electrical compression heat pump, the results shows that the annual costs of DH are ~ 19% (EUR 430 cheaper) lower compared to an individual natural gas boiler and ~ 30-31% cheaper (EUR 805) than an individual biomass boiler or individual air-to-water heat pump.[113] The study assumed no pre-existing heating systems in the area (neither DH nor individual heating). The results show that heat demand and district network length are important variables. The figures below show the assumed costs, efficiency, lifetime and other parameters used to make the assessment. The results cannot be extrapolated to other member states are they are dependent on fuel prices, tariffs and taxes which vary from country to country. However, it can be concluded that densely populated areas should be the starting point for establishing new DH networks in other countries/cities outside of Denmark.* *Figure 81 - Parameters for individual heating technologies and the district heating unit[114]*

| Type of heating | Investment [€] | Efficiency[%] | Lifetime [years] | Maintenance [€/year] |
|---|---|---|---|---|
| District heating unit | 6175 | 100 | 25 | 65 |
| Oil boiler | 7515 | 92 | 20 | 295 |
| Wood pellet boiler | 10 740 | 80 | 20 | 605 |
| Natural gas boiler | 6440 | 92* | 19* | 255 |
| Electrical panel/radiators | 4965 | 100 | 30 | 65 |
| Air-to-water heat pump | 12 485 | 233* | 15* | 360 |
| Ground source heat pump | 20 000 | 263* | 20 | 360 |

*Figure 82 - Parameters for district heating technologies[115]*

| | Wood chip boiler | Electrical heat pump | Storage tank | Eletric boiler |
|---|---|---|---|---|
| Investment [mio. €/$MW_{heat}$] | 0.74 | 0.7 | 155[1] | 0.08 |
| Efficiency (LHV) [%] | 108[2] | 400 | 95 | 99 |
| Lifetime [years] | 20 | 20[3] | 20[4] | 20 |
| Fixed O&M [€/$MW_{heat}$] | 10 335 | 2010 | 0[5] | 1210 |
| Variable O&M [€/MWh] | 25 | 15 | 0[6] | 4 |

[113] Green Energy Association (2018) The competitiveness of district heating compared to individual heating: When is district heating the cheapest source of heating?
[114] Ibid.
[115] Ibid.

*Figure 83 - Comparison of the price of heat for new DH heat (wood chip boiler) and individual heating. Heat demand at 13800 KWh/year, Network Scale of 1 (small pipe grid)*

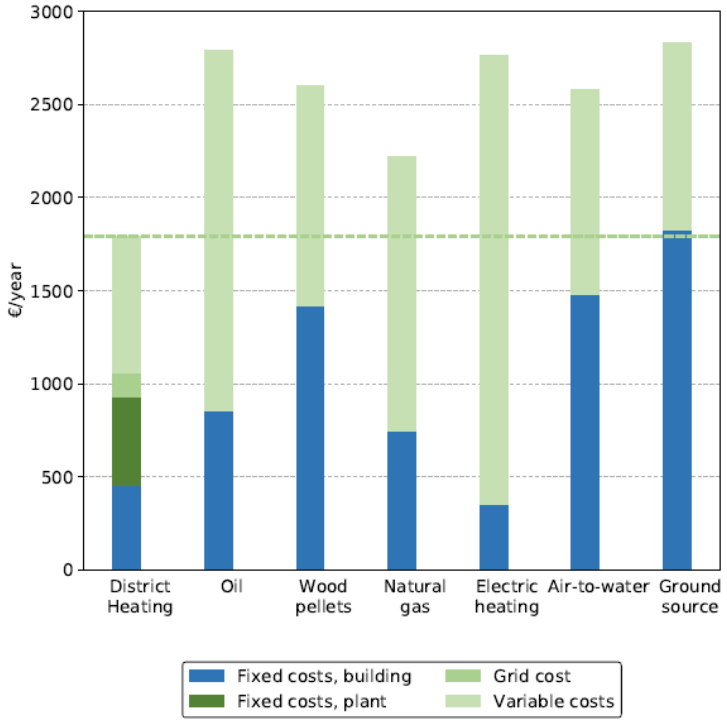



*Figure 84 - Comparison of price of heat from new DH (wood chip boiler) and individual heating. Heat demand of 4 900 kWh/year and Network Scale 1 (small pipe gird)*

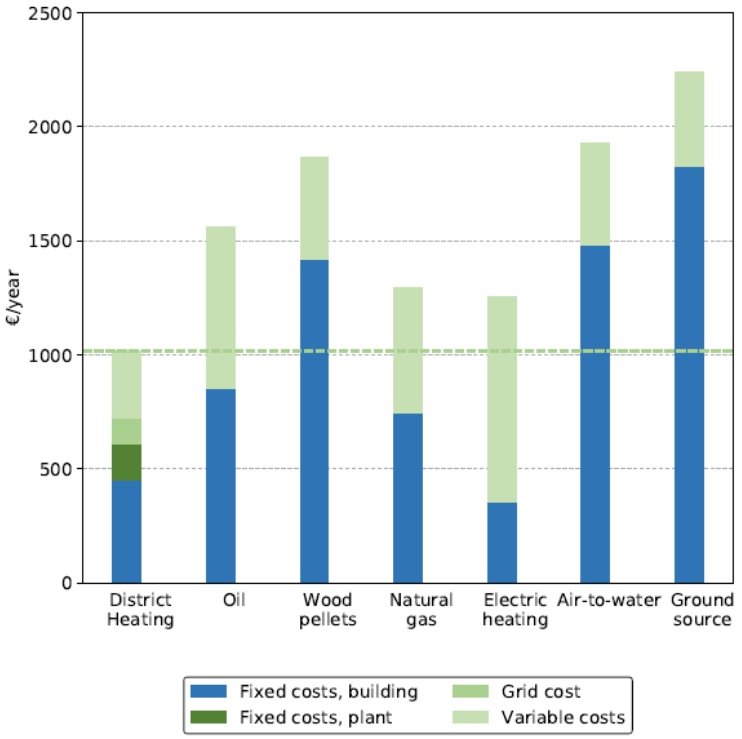
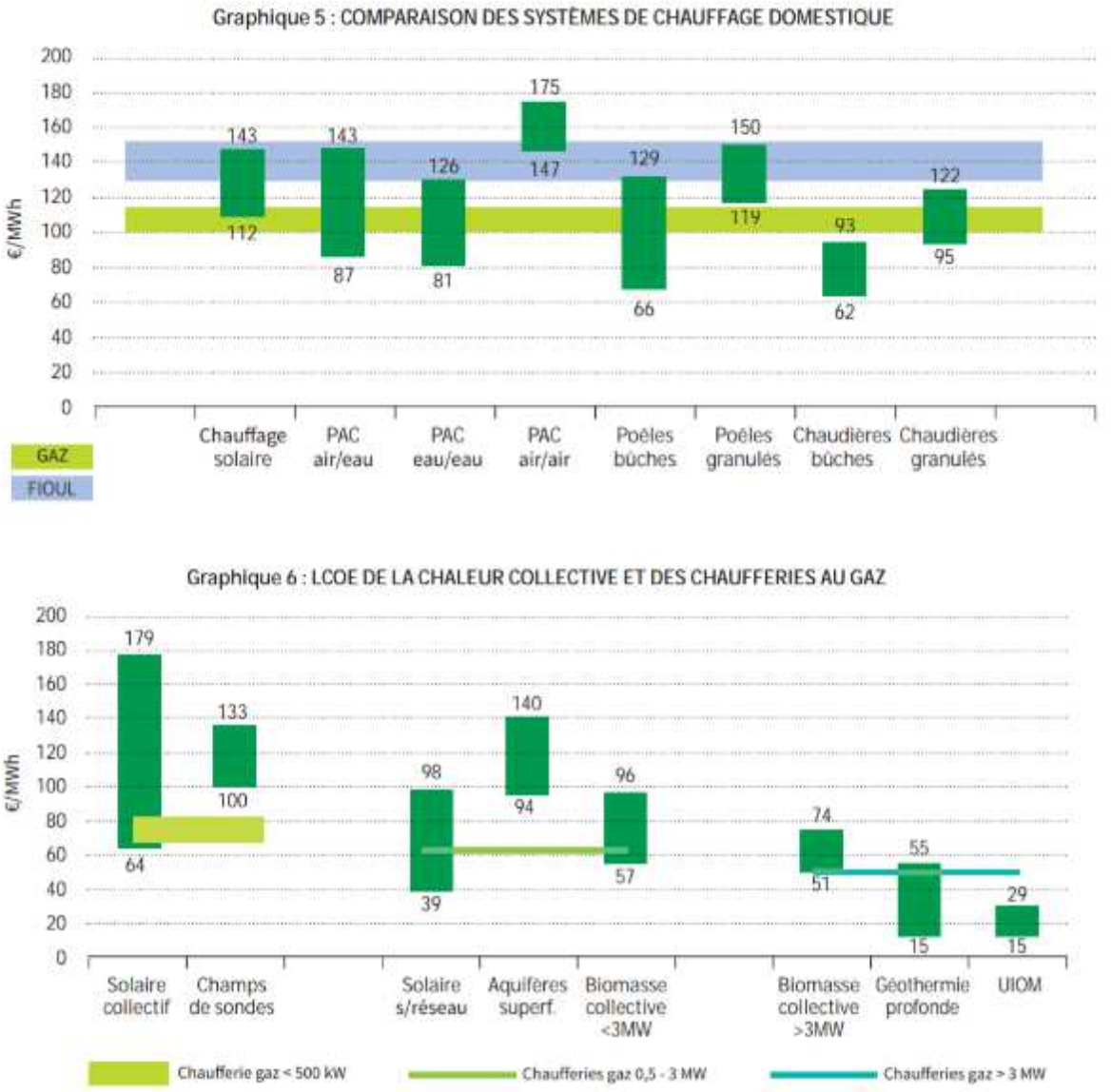


*Figure 85 - Comparison of individual heating systems (systems de chauffage domestique) & of district heating systems (LCOE de la chaleur collective)*[116]




## *Summary of case studies upgrading existing DHC*[117]

### 1. Sisak, Croatia

It has been determined early in the project that the most upgrading measure for the district heating system in Sisak is the implementation of the **thermal storage unit** in the form of the buffer tank. Given the high interest of the relevant stakeholders to significantly improve the efficiency of the system, the business model has been developed in a close cooperation with all of them (incl. heat production and heat distribution companies in Sisak (HEP Proizvodnja and HEP Toplinarstvo)), which enabled achieving a high level of detail and accuracy of the analysis. The investment cost of the 66.6MWh steel tank (incl. 12 MW heat exchanger, foundations, measurement equipment and connection pipes), was about 1.6M€, with linear

[116] Coûts énergies renouvelables et de recuperation, ADEME, 2020 (data 2019)
[117] https://www.upgrade-dh.eu/images/Publications%20and%20Reports/UpgradeDH%20D5.5.pdf

depreciation through different time periods (i.e. equipment 10 years, civil works 15 years). The thermal storage was to be owned by the HEP Proizvodnja, owner and operator of the existing biomass cogeneration unit (storage was expected to improve the efficiency of the CHP). Since this project would fall into the category of small projects in the HEP Group portfolio based on its investment costs, it is most likely that the funds would be provided by the HEP Group itself, i.e. no loan would be needed. However, both the scenario with 50% bank loan and the scenario without the loan have been analysed to cover both cases. For thermal storage integration in Sisak, revenues would consist of **reduced peak load boiler use** and the **reduced use of steam line during the summer period**. These are both reflected in the lower consumption of natural gas and amount to 312,440 €/a. On the other hand, the costs of the project are rather lower, since there is no need for additional personnel or additional software. Therefore, they consist of the operation and maintenance costs and the insurance costs and amount to 10,539 €/a. By taking into account all these parameters, the lifetime of the project (20 years) and the discount rate (5%, to discount future cashflows to the present value), the net present value of the project has been calculated at ~1.5M€, giving the internal rate of return of 14.9% and the payback period of 6.1 years. The project would have a relevant socio-environmental impact at the local level, decreasing the emissions CO2 emissions by 2,145 t, NOx emissions by 382 kg, SO2 emissions by 12 kg and CH4 emissions by 115 kg.

**2. Marburg, Germany**

The municipal utility - Stadtwerke Marburg (SWMR) – is responsible for the whole district heating process chain, from generation to distribution and sales. Detailed hydraulic calculations of the DH grid with different scenarios and multiple upgrade opportunities identified the UM "**optimisation of the pump operation**" to be the most relevant topic, which could be the case for many other DH systems. The cost-effectiveness of replacing the network pumps often does not appear economic at first glance, as the investment costs only appear to be offset by small savings. The ownership model and the DH business itself will not be affected by replacing the pumps. In most cases, pumps prove to be robust components that, if operated and maintained properly, will still work properly after several decades. For the example in Marburg the Pumps were built in the 60s and are still running with no major problems. If only the simple replacement of old pumps by new pumps of the same size is considered a business case, the investment cost are easy to identify. A typical DH system is designed for a specific maximum heat demand at a certain temperature level. In the last decades a lot has changed, new generation plants reach efficient operating conditions at much lower temperatures, still sufficient for space heating; the energy demand of individual consumers is decreasing (e.g. due to better insulation materials or warmer outside temperatures during winter). Hence, the initial planned pumping power is oversized, and the pumps are operating in inefficient part load situations all over the year.

For the reliable supply of the customers of a district heating system it is important, that the appropriate amount of heat can be transported through the DH grid. The technical analysis showed that the DH system could be operated reliably when the installed pumping capacity is reduced from ≈250 kW to ≈120 kW, for an increase in efficiency of ~25%. Yearly savings are estimated at ~74k€, with an investment around 95k€.

**3. Middelfart, Denmark**

The upgrading measures considered in the city of Middelfart are the result of a long collaboration between the local district heating company Middelfart Fjernvarme Amba, and

the consultancy company COWI. Since the beginning of the Upgrade DH project, the focus of the upgrading was to increase the share of renewables in the heat production as well as to improve the use of the available resources, and to optimize the management of the network. Before 2018, approximatly 2/3 of the heat supplied to the DH transmission system TVIS was from a natural gas fired CHP plant. With increased focus on climate changes and the higher standards required by the Danish governments, the Municipalities (including Middelfart Municipality) supplied by the TVIS system, agreed to convert the CHP plant to biomass. It increases the share of CO2 neutral production units from 27% to 94% in 2020 and thereby decreases CO2 emission by ~83% (reduction of CO2 ~ 10,000 $tCO_2$ eq/y). The woodchip-based CHP plant (90 MWel & 230 MWth) supplies heat for the district heating transmission system TVIS (main heat supplier for the DH network). The initial investment is around 200 M€, which leads to an evaluation of the financing resources, which requires access to a bank loan. Afterwards, considering the operation and maintenance cost, the revenue of the heat sales and the savings obtained by using biomass, the expected payback period was calculated to be around 25 years. The sensitivity analysis showed that the **variation of natural gas and biomass prices have a high impact of the feasibility of the project**. The utility Ørsted is the owner of the plant, which is the main actor involved. However, the conversion costs were covered with the contribution of the TVIS transmission system, which is a partnership of the four municipalities that are supplied by the system, where Middelfart Municipality has around 8% of the shares.

The ownership of the production system and transmission system are going to be the same after the conversion. Due to the high focus on the sustainability and CO2 reduction targets established by the Danish government, the project was further evaluated for the environmental costs/benefits and it was considered as feasible. The refurbishment of old service pipes was also considered, for network optimization, which was based on employees' knowledge of the network as well as based on not verified assumptions. By combining a Termis analysis of the service pipes and measurements allowed to identify the areas where the service pipes are in poor conditions. Based on that, it will be possible to plan the replacement of the existing pipes in a more efficient way, giving the priority to the service pipes that affect the network's performances the most. Middelfart DH company allocates every year around 1.35M€ of the income from heat sales for the renovation of the DH network, and more specifically for the service pipes. It guarantees a continued check and upgrade of the distribution network in the municipality. The evaluation of the investment considered an upgrade of the Termis system, which is installed in Middelfart of ~13k€, helping to replace the pipes in bad conditions at first (with a 2 years payback). There is a close collaboration between the district heating company and the consultancy company to use the results in the most efficient way and to further develop the tool.

### 4. Bologna, Italy

Berti-Pichat is a complex system, which features heat/chill/electricityprovision. The 3 CHP engines do manage to provide for the base load, yet gas boilers are vastly used during the peaks of heating season.

The investment is about installing heat pumps in the system, allowing for a greater utilization of the CHP units, while recovering a share of heat not currently utilized (because of its low temperature) and decreasing the usage of gas-fired boilers. The implementation phase involves significant investment costs linked to mechanical/hydraulic interventions, as well as

IT activities for SCADA connection. Cogeneration in Italy is subject to subsidies to the extent its "high efficiency" can be proven. The other main revenue driver is constituted by the avoided costs of gas boilers consumption, whose usage should decrease significantly as the heat pumps are operating in the heating season. The operating costs connected to the upgrading measure are constituted by the electricity consumption of the heat pumps (in terms of missed electricity sale) and the maintenance costs for the asset.

The significant capital investment is expected to reach breakeven within 3 years, leveraging also on regulatory incentives (related to high-efficiency cogeneration). Sensitivity analyses were carried out, in order to assess the investment parameters in case of a fluctuation of the main drivers (gas prices, cogeneration incentive structure, electricity market prices), outlining that the returns were still very promisingeven in the most negative scenario. The concept of smart substations involves a significant infrastructural effort, requiring to enable the metering on both the primary and secondary side with fine granularity. The measure aims at achieving a better customer knowledge and profiling through advanced analytics, while decreasing pumping costs (better regulation).

### 5. Salcininkai, Lithuania

"Salcininku silumos tinklai" is the municipality's district heating company that operates 14 boiler houses in Šalčininkai county in which it produces and distributes heat to residents and institutions in 10 different locations. The total installed heating capacity is 48 MW. Heat is supplied via 18.7 km long pipelines which are connected to 2,168 consumers, 96.8% of whom are residents. The heating systems at user size are usually designed for 80/60°C temperatures. The design temperature for hot water is 52°C. The supply temperature varies from 70 to 95°C throughout the year. most significant areas of impacts that the company seeks to improve is heat distribution. Investments in infrastructure of pipelines in the district heating network of Salcininkai started more than 30 years ago. Throughout the existence of this DH system, millions were invested. The seriousness of the issue and necessity of network optimization was identified by comparing DH system parameters to other DH systems of the country. Technological heat losses in 2018 were 10.2 GWh, which stands for 26.1% of the total heat produced. Network insulation is outdated in many places and does not ensure the thermal conductivity requirements which leads to considerable heat losses. Network optimization is a long-term step by step strategic approach which will lead to more efficient DH network.

The boiler used to meet the low summer demand is 6.5 MW to deliver peak demand ~1MW, hence decreasing the lifetime of the boiler and highly reducing its efficiency. The installation of a solar collector field with a possible heat storage implementation to the current boiler house would eliminate the inefficiency of low summer demand supply. It would increase the annual average efficiency of the current biomass boiler by eliminating the need of boiler for summer. The heat production would be more flexible, efficient, and diverse. The lifetime of the current main heating source would be prolonged and primary energy demand would decrease.

The integration of solar thermal energy into existing DH system is a complex combination of finding the right balance between size of investment and the right selection of working modes. In such system, to ensure optimum system performance and maximum usage of solar energy, it is necessary to install the heat storage and use the existing heat source (biomass boiler) only if the energy produced and stored by the sun is not enough. The total investment for solar thermal implementation (combination of 11,600 m2 solar collector field, 2,600 m3

volume heat storage and other auxiliary equipment) in the main district heating system of Salcininkai would cost ~ 4M€. The only potential funding sources for the pipe refurbishment will be funds of the DH company and loans depending on the scale of the project and the company's financial situation during the implementation moment. The solar thermal system combined with thermal storage would lead to elimination gas boiler usage during the short-term peak demand periods, and to reduce CO2 emissions (~236 $tCO_2$ eq/a).

Taking into consideration subsidy schemes for solar thermal energy available today, the project could be financed from the European Structural Funds by up to 50% of the eligible costs. Due to the fact that the loan will be quite significant for the company and its capital might not be sufficient enough therefore municipality might give guarantee to the bank in order to help DH company to implement the project. Private capital of DH company is usually used as security deposit (mortgage) for the bank.

Finally, the network optimization will most likely be a 30-year refurbishment plan which means revenue will increase on a year by year basis, leading to increasing primary energy demand reduction.

From these cases, it seems clear how important technical guidance helps the upgrade (EE & RES) of existing DHC, even when the business cases are very attractive. In all cases, an external guidance (via the Upgrade DH project) was necessary to initiate, support the identification of upgrading measures, and coordinate all works.

Another important aspect to consider, is that for the longer pay back investments, the economic feasibility would not be sufficient and therefore would need additional policy, like support from public authorities, or emission reduction targets, to steer and incentivize the concerned parties (heat producers or network operators).

A key issue to tackle, as illustrated by several cases (Middelfart, Bologna, ), is that the sensitivity is very high when it comes to variations of natural gas and biomass prices. Hence, there is a need for an overall regulatory environment, including from the EU level, that levels the playing field with gas and other fossil fuels, like the ETD and ETS (including ETS extended to building). This level playing field should work at large scale (such as in the case of Middelfart) to incentivise the switch to renewable in existing DHC. It also become critical for the deployment of new DHC systems, where those would compete with individual heating systems, particularly gas boilers as it would deploy mainly in urban areas, which are more connected to gas than rural areas.

Last but not least, from these cases (especially the replacement of gas supply by biomass, solar heat, or heat pumps), additional financial support may be required, to bridge the gap and, for these renewable investments, to reach the competitiveness level of gas (CHP or gas).Long term refurbishment and optimization plans of existing DHC (incl. their extension) are useful approaches to continuously look for efficiency improvements, regarding operation but also new investments and refurbishments. Such approach would also tackle all changes in demand pattern, such as lower demand, or decrease in temperature requirements. A good example of long term planning is given by the utility of the city of Munich, Stadtwerke München (SWM) with the implementation of its climate targets, replacing coal from lignite plants by geothermal district heating for 560,000 households by 2040.[118]The Upgrade DH cases also illustrate (e.g. in Lithuania) the interest of diversifying the energy

[118] https://www.thinkgeoenergy.com/munich-targeting-geothermal-district-heating-for-560000-households/

supply side, providing additional flexibility, also linked to market opportunities, to the overall DHC system.

*Options of specific measures on district heating and cooling*

***Option 2b)-B0:*** *Align the definition of 'efficient district heating and cooling with the CTP and EGD.*

The current definition is spelled out in Article 2(41) of EED and integrated into REDII by reference in its Article 2(20). This definition provides the criterion as regards which DHC systems should allow disconnection, network access or should align with the 1 ppt annual renewable increase rate under REDII. The current definition makes it possible for 100% fossil fuel systems to be qualified efficient indefinitely in the future. The review of the definition is an option under the EED review and therefore is not proposed as an option under the REDII review. Full consistency of its review under the EED should be ensured with the REDII review.

***Option 2b)-B1****: Eliminate exceptions and make access to networks mandatory for renewables and other carbon-neutral sources (waste heat), including from prosumers, in large DHC networks.*

– *Introduction on access regimes to DHC networks*[119]

DHC systems are natural monopolies. A natural monopoly exists whenever, due to high fixed costs and low marginal costs, it is cheaper if only one company and not several competing companies supply the market. Natural monopolies occur primarily in the area of grid-bound supply systems. In the energy sector, these include, for example, grid operation in the electricity, gas and district heating markets. In all these markets it would not make sense for several companies within a city or region to operate supply networks in parallel. Instead, parallel operation would lead to higher overall costs. Due to lower connection densities (the connections would then be distributed between the two or more parallel networks), the network costs per kilowatt hour would also rise.

In order to prevent natural monopolists from abusing their market dominance, the markets concerned require a minimum level of regulation. In particular, this applies to network operation. The core of regulation is typically the connection and usage conditions of the infrastructure.

The liberalization (market entry or exit) of the electricity and gas sectors has introduced competition in the respective markets on both the supply side (generation) and the demand side (retail). Different producers can feed in energy at different grid levels, consumers can choose between different suppliers. In the DH market, a comparable opening of the market is lacking in most European countries. In many European countries, the DH sector is seen as an integrated infrastructure in which generation, grid operation and distribution are operated in an integrated manner by one company in a city or region.

However, while the DHC grid can be regarded as a natural monopoly, this does not automatically apply to the other elements of the supply chain, e.g. the production side and/ or retail. A second competitor does not face high sunk costs. While technical restrictions,

[119] DHC Trend Study, ENER/C1/2018-496, ongoing.

especially for smaller grids, might inhibit an economic operation of more than one production unit, a competitive heat production market is generally possible in larger networks.

The Renewable Energy Directive II (Directive (EU) 2018/2001) calls on the Member States to increase the share of renewable energies in the grid-based heating and cooling supply. Art. 24 of RED-II opens up two ways of doing this,

- either by the implementation of measures aimed at increasing the share of RES in heating and cooling networks by 1 % per year,

- or by granting producers of renewable heat/cold or waste heat access to the grid (Third Party Access TPA).

So far, there is only little scientific literature on third party access to heating and cooling networks. In particular, cooling networks are almost never explicitly mentioned in this context. A distinction is made between network access models and single buyer models or "regulated" and "negotiated" TPA.

- Network Access Model: Producers have access to heat networks provided that they supply heat to their own end-customers, which could be new customers or existing customers of the incumbent vertically integrated grid operator

- Single Buyer Model: Producers are entitled to feed heat into a DH grid while the grid operator (single buyer) is obliged to accept and pay for the heat. Under such an approach, consumers do not have any choice between different suppliers, they are all supplied by the single buyer. Regarding grid access different models apply:

    - negotiated voluntary network access under which “the DH operator and supplier” (requesting grid access) “determine, on a voluntary basis, how to set up the heat dispatch order to the DH network”;

    - negotiated mandatory network access with a clear obligation to grid operators to enable grid access. However, the (technical and economic) conditions for grid access still need to be negotiated between the parties involved;

    - fully regulated network access, where the regulator determines ex-ante access provisions for grid access. Here, the network operator is obliged to provide access to the network if these conditions are met by the heat producer requesting grid access.

The literature distinguishes between systems called “regulated TPA” and “negotiated TPA”. Whereas “negotiated TPA implies that the DH network owners are required to negotiate about access to the network with the producers of heat”, regulated TPA refers to a regime “where the network owner has a legal obligation to allow access to the network” while the conditions for access to the network are negotiated between the network operator and the third party in advance. In both cases, customers have the right to choose their own supplier. Moreover, describe single buyer models and a system called “extended producer market”. The latter is a certain form of a single buyer model, extended by high transparency rules for all market actors. The idea of

this model is that due to clear unbundling rules and high transparency requirements regulation efforts can be reduced.

However, there are many more conceptual options to open heating networks for third parties. This includes the option - over and above the requirements of RED-II - of opening heating networks to competition at the supply side, referred to as "full TPA" instead of restricting network opening on the generation side, referred to as "producer TPA".

*Table 52 - Overview of TPA regulations in the Member States, the UK, Iceland, Norway and Ukraine(Source: ENER/C1/2018-496, ongoing)*

| | | | | If TPA is allowed (at least in principle) | | | |
|---|---|---|---|---|---|---|---|
| Country | Regulation on TPA | Restrictions for TPA | Exceptions for TPA | Open retail market (full TPA) | Producer TPA | Regulation of grid access: mandatory vs. voluntary | Regulation of grid access: negotiated vs. regulated |
| Austria | No | - | - | No | Yes | voluntary | negotiated |
| Belgium[1)] | No | - | - | Yes | Yes | voluntary | negotiated |
| Bulgaria | Yes | No | a,b,d[3)] | No | Yes | mandatory | regulated |
| Croatia | | | | | | | |
| Cyprus | No DH in Cyprus | | | | | | |
| Czech Republic | Yes | I,II[2)] | a,b,c[3)] | No | Yes | mandatory | negotiated |
| Denmark | No | - | - | - | Yes | voluntary | negotiated |
| Estonia | Yes | I[2)] | No | No | Yes | mandatory | regulated |
| Finland | No | - | - | No | Yes | voluntary | negotiated |
| France | No | - | - | No | Yes | voluntary | negotiated |
| Germany | No | - | - | No | Yes | voluntary | negotiated |
| Greece | No | - | - | - | - | - | - |
| Hungary | No | - | - | No | Yes | voluntary | negotiated |
| Ireland | No | - | - | No | Yes | voluntary | negotiated |
| Italy | No | - | b[3)] | No | Yes | voluntary | negotiated |
| Latvia | Yes | | | Yes | Yes | mandatory | negotiated |
| Lithuania | Yes | - | a,b,c[3)] | No | Yes | mandatory | regulated |
| Luxembourg | | | | | | | |
| Malta | No DH in Malta | | | | | | |
| Netherlands | Yes | - | - | No | Yes | voluntary | negotiated |
| Poland | Yes | - | c[3)] | Yes | Yes | mandatory | negotiated |
| Portugal | | | | | | | |
| Romania | Yes | ? | | ? | ? | ? | ? |
| Slovenia | | | | | | | |
| Slovakia | Yes | II[2)] | a,b,c[3)] | No | Yes | mandatory | |
| Spain | No | - | - | - | - | - | - |
| Sweden | Yes | II[2)] | c[3)] | No | Yes | mandatory | negotiated |
| UK | No | - | - | - | - | - | - |
| Norway | Yes | No | a,b,c[3)] | Yes | Yes | mandatory | negotiated |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Iceland | | | | | | | |
| Ukraine | | | | | | | |

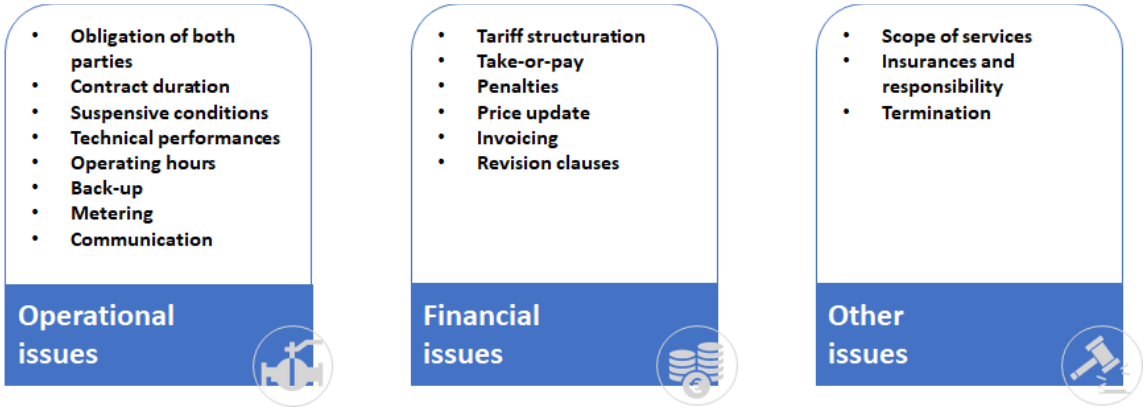
[1] *Answers are only provided for Flanders as there is no legal framework on DHC in place in Brussels and Wallonia.*

[2] *(I) Occasions at which TPA is required (e.g. TPA required when new demand needs to be covered or existing heat production capacities need to be replaced), (II) TPA for RES-H/excess heat only, (III TPA restricted to large DHC systems*

[3] *(a) Grid lacks the necessary capacity, (b) heat does not meet the required technical parameters, (c) negative impact on costs for customers, (d) other reasons*

*Source:Own survey with input from national DHC stakeholders*

TPA regulation is not yet well developed in most of the countries studied. In about half of the analysed countries, TPA is regulated in some form. However, there are significant differences in the regulation depth. In the other half of the countries there is no explicit regulation of TPA.




Contractual modalities for third party access, Source: ENER/C1/2018-496, ongoing

***Option 2b)-B2*** *Enhanced energy system integration between DHC systems and other energy networks*

- coordination and common market operation of DHC systems with electricity distribution (DSO) and transmission system operators (TSO) for flexibility services, demand response and related investment in infrastructure and generation assets;
- coordination and common market operation of DHC systems with gas distribution system operators, hydrogen and other energy networks - in addition to with electricity operators.

It is coherent with the Energy System Integration Strategy (ESI), which states that modern low temperature district heating systems should be promoted, as they can connect local demand with renewable and waste energy sources, as well as the wider electric and gas grid – contributing to the optimisation of supply and demand across energy carriers. ESI requires accelerated investment in smart, highly-efficient, renewables-based district heating and cooling networks, if appropriate by proposing stronger obligations through the revision of the

Renewable Energy Directive and the Energy Efficiency Directive and the financing of flagship projects.

Improving coordination and market operation of district heating and cooling systems with electricity distribution (DSO) and transmission system operators (TSOs) will improve energy system integration generally. This option builds on current provisions (in Article 24(8)) regarding cooperation with DSO. Adding TSO or further adding gas distribution system operators, hydrogen and other energy networks would allow benefitting from more sector integration possibilities at limited additional administrative cost.

***Option 2b)-B3*** *Enhance energy system integration for waste heat and cold use via a coordination framework for key actors*

It would overcome the challenge highlighted in the ESI that local energy sources are insufficiently or not effectively used in our buildings and communities. The option is coherent with ESI and Circular Economy principles. According to ESDI applying the principle of circularity in line with the new Circular Economy Action Plan, a big, yet largely unused potential is the reuse of waste heat from industrial sites, data centres, or other sources could be realised. An important part of energy reuse is feeding waste heat/cold into district heating and cooling networks.

### Effectiveness

**Global planning of DHC (incl. coordination with gas infra)**

Several European countries have inefficient district heating systems[120], designed for high temperatures. These district heating systems face the double issue of establishing new systems as well as consolidating and expanding existing ones while improving efficiency and increasing the share of renewable in these systems and building sectors. Many of these systems will have to move from 1st and 2nd generation district heating to 3rd or 4th generation systems. This can happen with new production units, access to new renewable resources, efficient distribution infrastructure, highly efficient buildings that can utilise low temperature supply and with improved heating controls, heat metering and consumption-based billing. A starting point should be to move towards demand-driven systems where customers can actively control their consumption. New systems should be established using state-of-the-art technologies along the value chain.

Clear district heating regulation and planning can be the determining factor in the decarbonisation of the H&C and especially in the widespread use of DHC.[121] Such regulation could address several principles involving local authorities, such as bearing the responsibility to approve new H&C supply and distribution projects, setting up rules to ensure the projects with the highest socio-economic benefits is selected, using local resources as much as possible in the most efficient way by combining heat and power, establish rules to ensure the most competitive end-consumer price (low market price), empowering the end-consumer.

120 https://www.districtenergyinitiative.org/sites/default/files/publications/towardsadecarbonisedhcsectorineufinalreport-111220191046.pdf

121 The regulatory process, responsibilities and requirements when approving district heating projects in Denmark, as demonstrated in the District Energy – green heating & cooling for urban areas, State of Green 2020

A prioritisation of heat synergy regions/areas has been made for 14 Member States in the HRE4[122], based on spatial information for heat and cold demand and potential resources for heat production. This kind of mapping should help planning the deployment of DHC infrastructure, supporting planners, DHC operators and national/regional/local authorities.

The map below shows 4 types of regions/areas in the 14 Member States of the HRE4.

*Figure 86 - Heat synergy regions prioritised in 14 MS*

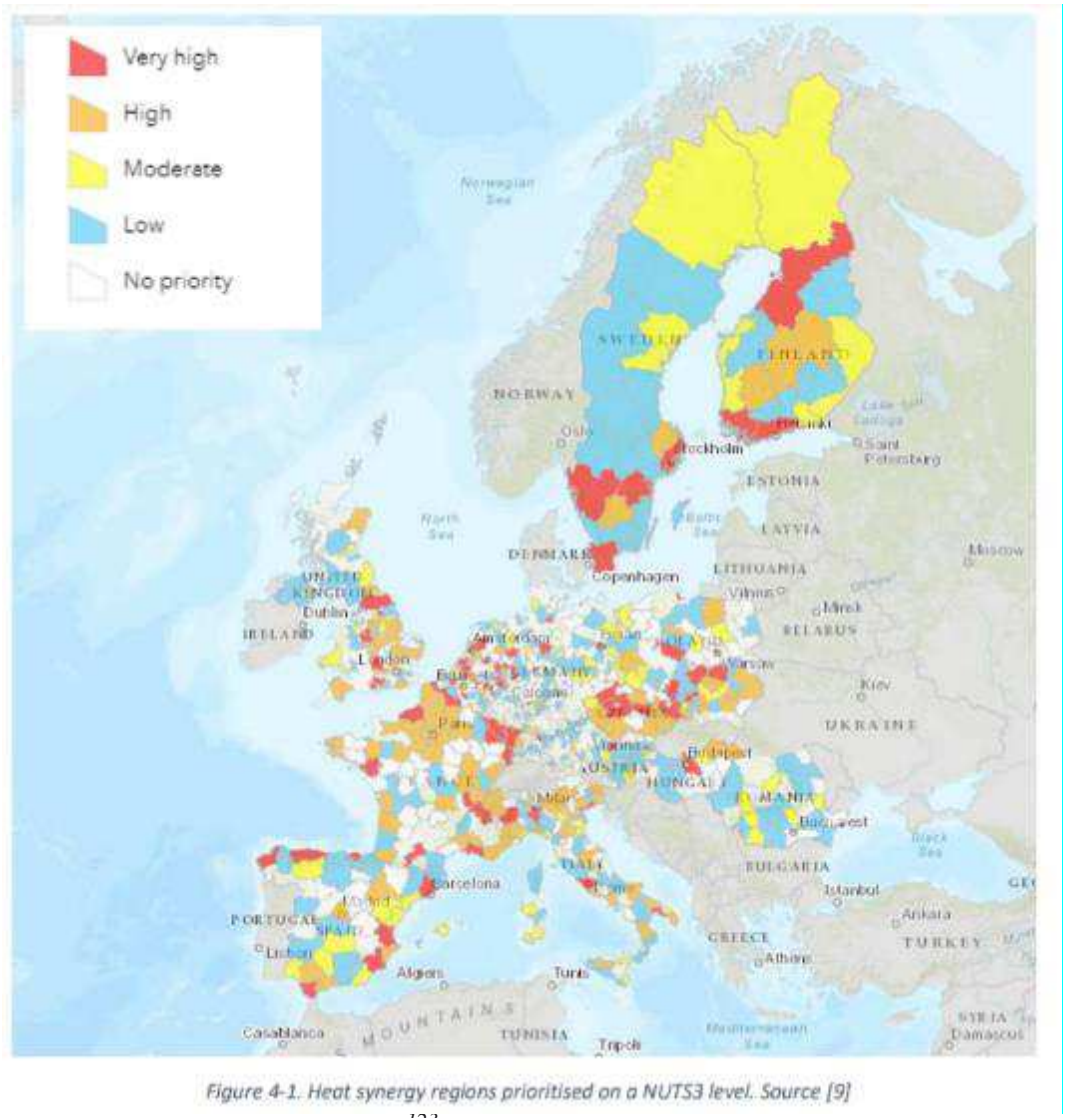



*Figure 4-1. Heat synergy regions prioritised on a NUTS3 level. Source [9]*

*Source: Heat Roadmap Europe*[123]

Regarding the conversion to new RES generation, considering the rather long lead time for planning and licensing new district heating and cooling systems and high upfront investment costs, medium and long-term planning of new DHC networks should be done by

[122] https://heatroadmap.eu/

[123] https://vbn.aau.dk/ws/portalfiles/portal/316535596/Towards_a_decarbonised_H_C_sector_in_EU_Final_Report.pdf

collaboration between local, and regional authorities and with national authorities overseeing these plans, but also with other infrastructure operators (such as gas DSO).

Building refurbishment programmes, electricity, telecommunication, water, or gas network investments and works are rarely implemented considering new DHC systems. Sustainable energy programmes targeting the decarbonisation and energy efficiency of buildings and the heating and cooling supply are often overlooked during the urban planning and design phase.

Decisions on investments in infrastructures and buildings at municipal or commercial levels may take place in an isolated manner without any consideration for the feasibility of long term sustainable solutions. Usually, no life cycle cost analysis is performed to assess the long-term cost-competitiveness of various options.

**Enhanced coordination of DHC systems with other energy infrastructure would support cost effective decarbonisation of the H&C**, especially in the case of gas networks that may either supply DHC (renewable gases such as biomethane or renewable hydrogen), either compete by extending their scope, and hence jeopardising DHC and/or becoming potential stranded assets. Therefore, any natural gas DSOs should consult energy planners & DHC operators to determine the most appropriate option for the long term decarbonisation of the H&C sector.

It is crucial to take an integrated approach towards the energy systems' planning, development, and operations across all energy infrastructures. In order to minimise total life cycle cost, building design & operation with district H&C systems using various renewable sources and carriers can work together to optimise temperature levels, time of use based on tariffs and price signals, store energy in the most cost-effective way, record and regulate load profiles, integrate weather forecasts, and anticipate price formation. Appropriate cross-sectoral software interfaces need to be established to achieve interoperability[124] also with the gas system (including hydrogen). Energy efficiency and the use of renewable H&C should be maximised and the synergies between them optimised by tapping into existing local renewable and associated innovative design and technologies. Planning tools and methodologies specific to the decarbonisation of DHC are necessary, in order to coherently model, analyse, and design H&C systems as an integral part of the entire energy system. Close collaboration between all network and infrastructure operators is required to ensure appropriate integrated planning.

In order to promote all types of energy utilisation and supply (all renewable sources), interaction between supply and demand as well as efficient operation, a new generation of energy systems which treat the district heating network as the centre piece is emerging. Unlike traditional energy systems, the DH network, electricity and gas networks in the new generation of energy systems are closely linked through CHP units, HP and other electricity and/or gas-driven heating systems and influence each other. Therefore, to ensure the safe operation of the future DH network and gas & electricity networks, the integrated framework for generation and infrastructure planning need to be carried out. While ensuring to meet all

[124] https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf

operation constraints, a multi-stage planning model for the combined generation, infrastructure, can minimize investment and operating costs of the combined systems. Combined generation, DH, electricity and gas networks expansion or adaptation planning is a large-scale, high-dimensional, nonlinear optimization problem, which is difficult to solve (sophisticated mathematical optimization method to quickly obtain the optimal solution may be required). This would first require the different operators to coordinate efficiently.

***Option 2b)-B4*** *Strengthen information provisions for consumers, such as:*

- requirement to include specific RES share and a numerical energy performance number (PEF) in the information district heating/cooling systems provide to consumer (e.g. on bills, suppliers/regulators' websites);
- Energy label (voluntary or mandatory) for DHC systems.

**Effectiveness**

Usually, in supply-driven systems, billing is often based on lump sums and hence the system is frequently seen as unfair and outdated. By evolving to more demand-driven system thanks to disclosure, consumers would adjust their energy consumption to their needs. Therefore, if consumption-based billing is paired to metering, consumers would also have an incentive to rationale energy use, which in turn, would pave the way to increase energy efficiency or through more regulation of energy use. The importance of metering in a demand-driven system reaches far beyond a proper billing of the energy consumed, since the deeper knowledge of the consumer patterns and conditions may enable the detection of faults in the consumer installations or demand-side management.[125] All these are mainly driven by efficiency purposes, but by providing information on the renewable and carbon content of the heat consumed, consumers would also more deeply follow the logic behind price formation and the energy sources used to produce heat.

**Customer's role**

A more active role of consumers in promoting high shares of renewable energy in district heating and cooling through the disclosure of district heating and cooling energy performance certificates, to be compared with building level energy performance certificates, would be supportive to make the adequate choice. This would incentivise the competition between most efficient energy performance solutions at the energy system or building level. Such competition is increasingly relevant as consumers are encouraged to invest in local renewable heating solutions, such as solar thermal systems, wood-pellet systems or heat pumps, under the energy performance of buildings directive. These local solutions could be complemented or replaced with renewables-based district heating and cooling systems to provide additional flexibility and performance. This variant increases competitiveness, and therefore economic impacts.

**Customers' rights**

125 https://www.districtenergyinitiative.org/sites/default/files/publications/towardsadecarbonisedhcsectorineufinalreport-111220191046.pdf

Regarding potential disconnections, since efficiency standard does not include minimum energy performance thresholds and since no data is available on how different DHC systems can be categorised based on efficiency levels, estimating the impact of a better information of the customers and increased rights to disconnect remains hypothetical.

Higher disconnection risk and impacts could be expected in Member States with proportionally higher DHC market shares, and globally lower energy efficiency of these DHC. Where the share of inefficient DH systems is large, stronger disconnection rights could severely impact the economic viability of these networks. However with other enabling instruments such as planning or risk mitigation, the risk of disconnection could also incentive these systems to modernise and offer attractive services to reduce consumers' willingness to disconnect.

The efficiency of labelling and disclosure to final customers, to promote the increase of energy performance of the DHC and the switch to renewable will depend on the ability of the Member States to raise awareness and effectively influence the willingness and interest of customers to envisage disconnecting. This could only happen if the renewable alternatives are effectively available and are competitive. But in any case, disconnection will remain difficult for a consumer and would be a last resort solution.

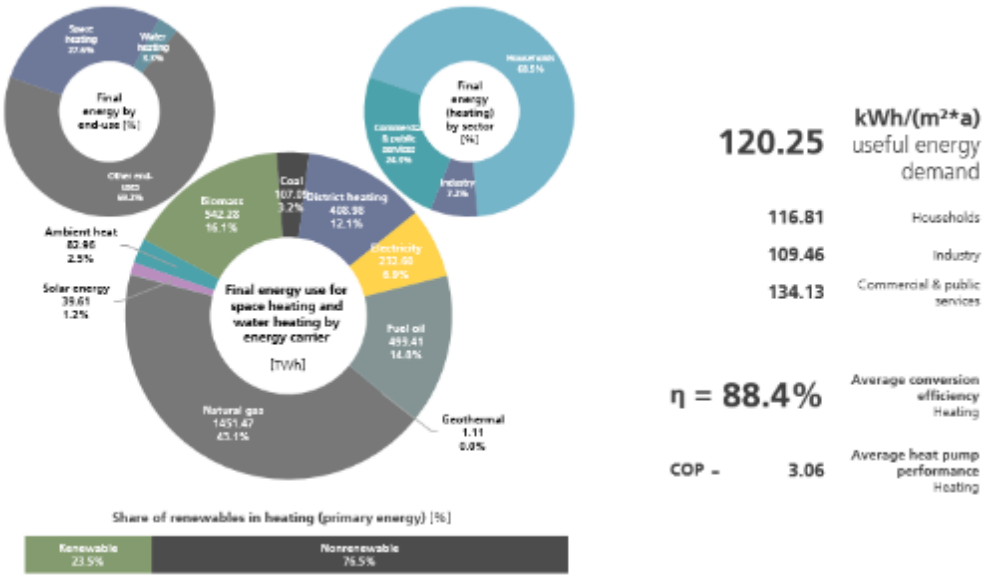
This variant extends the existing provision under article 24(1) regarding information to final consumers, by increasing transparency. Hence, it will be a minor amendment.

*Renewable energy in Buildings*

The shifting of buildings' heating and cooling systems away from fossil fuels to more renewable based systems is key to achieve the higher ambitions of the Green Deal and the CTP and for the decarbonisation of buildings[126]. According to the CTP, in order to achieve the 55% emission reduction target, by 2030 the EU should reduce buildings' greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18%. It is also crucial to reduce local air pollution, meaning that non-combustion renewables have to be prioritised. The Renovation Wave made decarbonisation of heating and cooling a priority area for action and promotes renewables in buildings. Current provisions in REDII include a general requirement for ensuring a minimum level of renewables in buildings without specifying it and so far as technically, functionally and economically feasible. The visibility of renewables in building, although they are the key drivers for improving energy performance, remains low and allows continued use of fossil fuels with limited use of renewables in new and refurbished buildings. Residential buildings constitute the largest heating consumers (68.5%), followed by the service sector buildings (24.3%) and industrial buildings (7.2%) as indicated in the figure below. The share of renewables in district heating supplying buildings is 28.2% composed mainly of biomass and renewable waste (26.9%), followed remotely by heat pumps (geothermal and ambient energy) (1.2%) and solar thermal (0.1%).

[126] The Energy Performance of Buildings Directive (revised) set the objective to decarbonise the EU building stock by 2050.

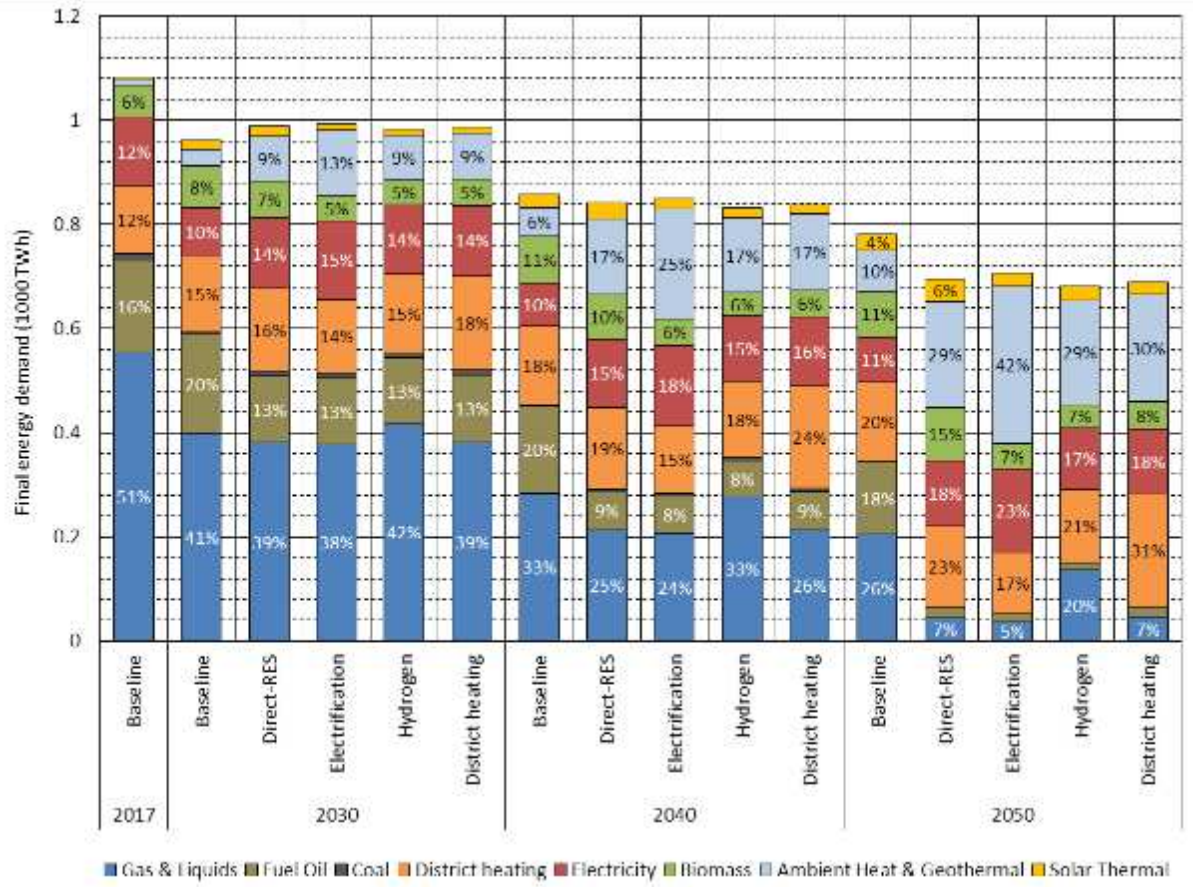
*Figure 87 - Renewables in buildings*




A dedicated study is analysing four core scenarios to decarbonise space heating (including domestic hot water). The four scenarios zooms on specific technology pathways: direct renewable heat, direct electrification, indirect electrification and district heating. While the study is still on-going, preliminary results show large energy consumption and related GHG reductions across all scenarios compared to baseline.[127] The figure below shows final energy demand for space and water heating by energy carrier. While final energy demand in the baseline scenario reduces from almost 4000 TWh/yr in 2017 by less than 30% until 2050, the different decarbonisation scenarios show significantly higher energy savings in the range of 35%. Counting delivered energy only (i.e. subtracting solar, ambient and geothermal energy, the reduction accounts to more than 60% in the electrification scenario, where heat pumps dominate the generation mix.

[127] The design of the scenarios is being refined and not all costs have yet been included in the modelling analyses, such as additional electricity generation capacities and dedicated infrastructures for $H_2$.

*Figure 88 - Final energy demand for space and water heating by energy carriers, EU-27 (+UK, CH, NO), 2017, 2030 and 2050 across scenarios, Source: Renewable space heating under the revised Renewable Energy Directive, ENER/C1/2018-494 (ongoing, only preliminary re*




Space heating and water heating in buildings (households, services, industry) accounts for 30.9% of final energy demand in the EU[128]. Households contribute most to heating demand, 68.5%; while services has a share of 24,3% and industry 7.2%. The energy carrier mix for space and water heating (final energy) is dominated by natural gas (43.1%), followed by biomass (16.1%) and fuel oil (14.8%). Based on the primary energy factors, the renewable share in the primary energy mix is 23.5%, while 76.5% is provided by fossil fuels. Consumption is inefficient with an average building consuming 120.25 kWh/m2/a compared to 50 kWh as most adopted value for nearly zero-energy buildings in Member States.

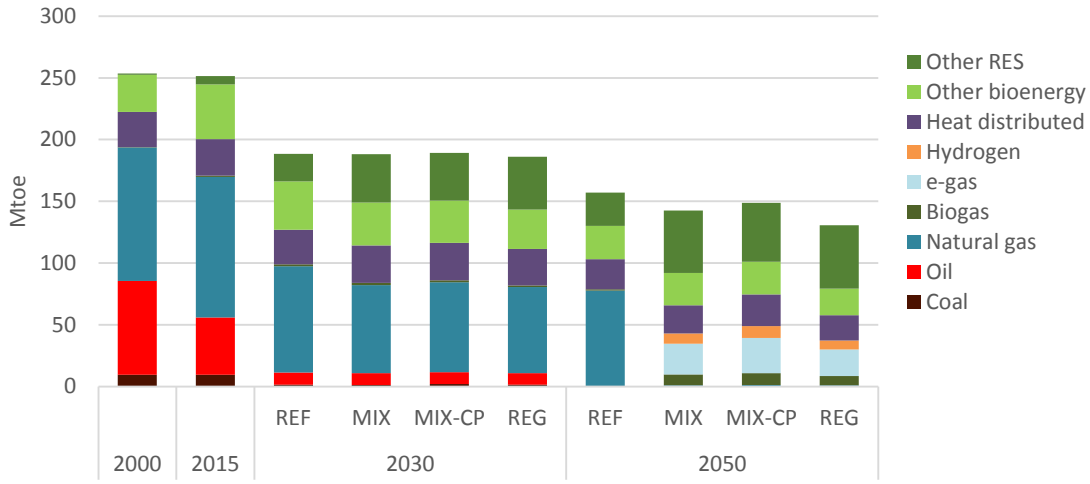
The shifting of buildings' heating and cooling systems away from fossil fuels to more renewable based systems is key to achieve the higher ambitions of the Green Deal and the CTP and for the decarbonisation of buildings129. According to the CTP, in order to achieve the 55% emission reduction target, by 2030 the EU should reduce buildings' greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18%. It is also crucial to reduce local air pollution, meaning that non-combustion renewables have to be prioritised. The Renovation Wave made decarbonisation

[128] Renewable Space Heating under the Revised Renewable Energy Directive, ENER/C1/2018-494, TU-Wien and alia, on-going. All values are calculated for 2017.
[129] The Energy Performance of Buildings Directive (revised) set the objective to decarbonise the EU building stock by 2050.

of heating and cooling a priority area for action and promotes renewables in buildings. Current provisions in REDII include a general requirement for ensuring a minimum level of renewables in buildings without specifying it and so far as technically, functionally and economically feasible. The visibility of renewables in building, although they are the key drivers for improving energy performance, remains low and allows continued use of fossil fuels with limited use of renewables in new and refurbished buildings.

Meanwhile, from CTP results, non-electricity fuels used only for heating purposes shows a decline of fossil fuels with MIX and MIX-CP showing that with the projected carbon pricing levels there is a strong impact on lowered demand for natural gas. Renewable energy (other than ambient heat required for heat pumps) increases its share in buildings in the REF in 2030 and in 2050 perspective. Biomass (used in modern stoves) remains stable over the 2020-2030 period. In modelling results, biogas, solar thermal and geothermal also have marginal shares in energy consumption. Distributed heat increases its shares to 16% in 2030.

*Figure 89 - Non-electricity fuel consumption in buildings*



## ANNEX 8: OVERVIEW BIOMASS PLANS FROM NATIONAL ENERGY AND CLIMATE PLANS

According to the Commission's assessment of the National Energy and Climate Plans (NECPs), a majority of Member States foresee an increase in bioenergy use from 2021-2030. However many of their national plans lack details on how to supply the required sustainable biomass, by feedstock and origin and trajectories for forest biomass, and how they are aligned with measures to maintain and increase the carbon sink. Below is a summary of the main findings by Member State.

AT: Increase of bioenergy, relying on "sustainable forest management" without further definition and without any consideration on biodiversity. There was a recommendation to analyse the sustainable supply of biomass and its impacts on LULUCF, not addressed.

BE: No assessment of biomass trajectory nor impacts on LULUCF.

BG: Refers to increase of use of biomass, but mainly coming from waste and residues + afforestation.

HR: Announced increase bioenergy with plantations of fast-growing species. The NECP announced a study on bioenergy, and several afforestation measures are announced.

CY: Bioenergy expected to play a major role on the energy mix; the draft NECP did not assessed the sustainable supply, nor impacts on sinks and biodiversity. In the final version, CY argued that no intention to use forest biomass (and therefore no impact on sinks), but the sustainable supply of biomass remained not assessed.

CZ: Expected expansion of bioenergy, relying on afforestation (mainly based on indigenous species, according to final plan). No trajectories on sustainable supply of biomass.

DK: The Commission recommendations to the draft NECP asked for details to ensure the sustainable supply of biomass, because bioenergy will play a major role in the mix. The final version announced a study on the sustainable supply and already provided some data.

EE: The NECP plan for RES increase relies strongly on bioenergy; the country announces a big loss of sinks in the NECP, harvesting is quite intense, but states that all forests are sustainable.

FI: NECP announces that bioenergy will continue to be predominant in the energy mix, and will further expand. The Commission asked in its SWD to the draft to assess its sustainable supply and impacts on biodiversity and sinks. The final report acknowledge that bioenergy is a potential problem for biodiversity, but ensures that the sustainable management is guaranteed. The plan refers to an impact assessment that recommends that incentives for biodiversity have to be introduced, but no mention about the status of such recommendations.

FR: Very prudent in the use of biomass and with an ad-hoc strategy which integrates sustainable supply and biodiversity.

DE: Another prudent case, where the plan explains that there is a limited availability of sustainable biomass, which should focus in sectors without alternatives. The maximum amount of bioenergy is even estimated and the focus in on other technologies (wind and solar) with more potential and lower costs.

EL: Increased use of bioenergy announced, mainly based on energy crops, woody biomass and coppice plantations + residues to avoid forest fires. No assessment of impacts on biodiversity and LULUCF sinks.

HU: Increased use of biomass, without assessment of sustainable supply or impacts on sinks and biodiversity, despite Commission recommendations.

IT: The Commission requested an analysis of trajectory of biomass supply and impacts on LULUCF, but the final version is according to my notes well nuanced, with safeguards for biodiversity and other environmental issues. Does not seem problematic.

IE: Bioenergy is planned to increase massively, especially from forestry. The final plan provides trajectories, but not impacts on sinks and biodiversity.

LIT: Unclear. The NECP refers to the cascading principle.

LU: Expected expansion of biomass for energy, with commitment about cascading use and sustainability. Intention to extend criteria to plants 10MW<X<20MW. Origin from "Grande Région". No actual assessment yet of supply potentials, and no link with biodiversity explained.

MT: Increased bioenergy demand, imported, without any assessment of sustainability, origin, etc.

NL: The Commission asked to analyse biomass supply trajectories, but the wording is very prudent on the impacts on biodiversity. Does not seem problematic.

PL: Projected increase in biomass use for energy, with a consistent increase in the share of final energy consumption to about 11 % by 2040. No assessment of impacts on biodiversity or sinks. Forest-related infringement procedure ongoing.

PT: Despite comments from the Commission, the final report does not seem problematic. Biodiversity well integrated, with measures to increase sinks in forestry and reduce agricultural emissions.

RO: Increase of bioenergy use. The final NECP acknowledge uncertainties and data gaps, and does not assess its sustainable supply. Illegal logging is a big issue. Forest-related infringement procedure ongoing.

ES: The plan foreseen a massive increase of bioenergy. Even if measures to further exploit waste and residues are mentioned, the sustainable supply of biomass and its impacts on carbon sinks is not properly assessed. There are issues with the use of biomass from eucalyptus plantations (and derived forest fires) in Galicia, and those plantations are extending to Asturias and, to lesser extent, to the Basque Country.

SE: The Commission requested an assessment of the sustainable supply of biomass. The final report covers biodiversity in very broad terms. SE argues that its forests are sustainably managed, but this is challenged in scientific literature and by NGOs.

SI: Projected increase of use of biomass. SI argues that "in modern individual, collective and industrial heating, heat and power plants is important for Slovenia, as this allows it to improve the reliability and competitiveness of energy provision, to reduce GHG emissions and to protect the environment". No assessment of climate and biodiversity implications, and no mention of concrete measures.

SK: Biomass projected to increase, without assessment of trajectories, sustainable supply and impacts on biodiversity or sinks

## ANNEX 9: BIOMASS AND BIOENERGY: ADDITIONAL INFORMATION

### SYNERGIES BETWEEN CLIMATE AND BIODIVERSITY, IMPLICATIONS FOR REDII SUSTAINABILITY CRITERIA DESIGN

Responding to a need identified in the EU Biodiversity Strategy for 2030 (COM/2020/380) the Commission committed to publishing a report[130] on the use of forest biomass for energy production. Bioenergy is the main renewable energy source in the EU and in many Member States, accounting for over 10% of EU final energy consumption and about 60% of renewable energy consumption. An objective was to ascertain if synergies could be identified to inform the EU climate and energy policies governing the sustainable use of forest biomass for energy production and the accounting of associated carbon impacts.

The report notes that EU legislation focuses the definition of environmentally sustainable bioenergy on biodiversity conservation and climate change mitigation, because bioenergy sits at the nexus of two of the main environmental crises of the 21st century: the biodiversity and climate emergencies. Wood-based bioenergy has the potential to provide part of the solution to both crises, but only when biomass is produced sustainably.

It is clarified in the report that woody bioenergy is not automatically assumed "carbon neutral" within the EU climate and energy policy framework for the period after 2020 – contrary to the legislative framework under the Kyoto Protocol. The Land Use, Land Use Change and Forestry (LULUCF) sector through Regulation 2018/841 now accounts the emissions (or removals) due to changes in forest carbon stocks and sinks against Member State accounts and targets, and consequently biomass emissions are not accounted again in the energy sector under Directive 2018/2001 (REDII).

The JRC analysis shows an increasing overall use of woody biomass in the EU in the past two decades (around 20% since 2000). Similarly, the subset of woody biomass used for the specific purpose of energy has followed an increasing trend until 2013 (about 87% from 2000-2013), after which the growth has slowed. According to the JRC analysis, wood-based bioenergy production is, to a large extent, based on secondary woody biomass (forest-based industry by-products and recovered post-consumer wood), which makes up almost half of the reported wood use (49%). Nevertheless, primary woody biomass (stemwood, treetops, branches, etc. harvested from forests) makes up at least 37% of the EU input mix of wood for energy production (and the remaining 14% is uncategorised in the reported statistics). Roughly 20% of the total wood used for energy production is made up of stemwood, while 17% is made up of other wood components (treetops, branches, etc.). 4% of total wood energy demand for energy is supply by industrial stem wood. Wood-pellets imports from US have a minor role in the EU after Brexit.

Considerable inconsistencies in reported data are identified: it is estimated that in the EU, the amount of woody biomass used exceeds the total amount of reported as sources by more than 20%, with large differences among Member States[131]. This identified gap also highlights a specific need to

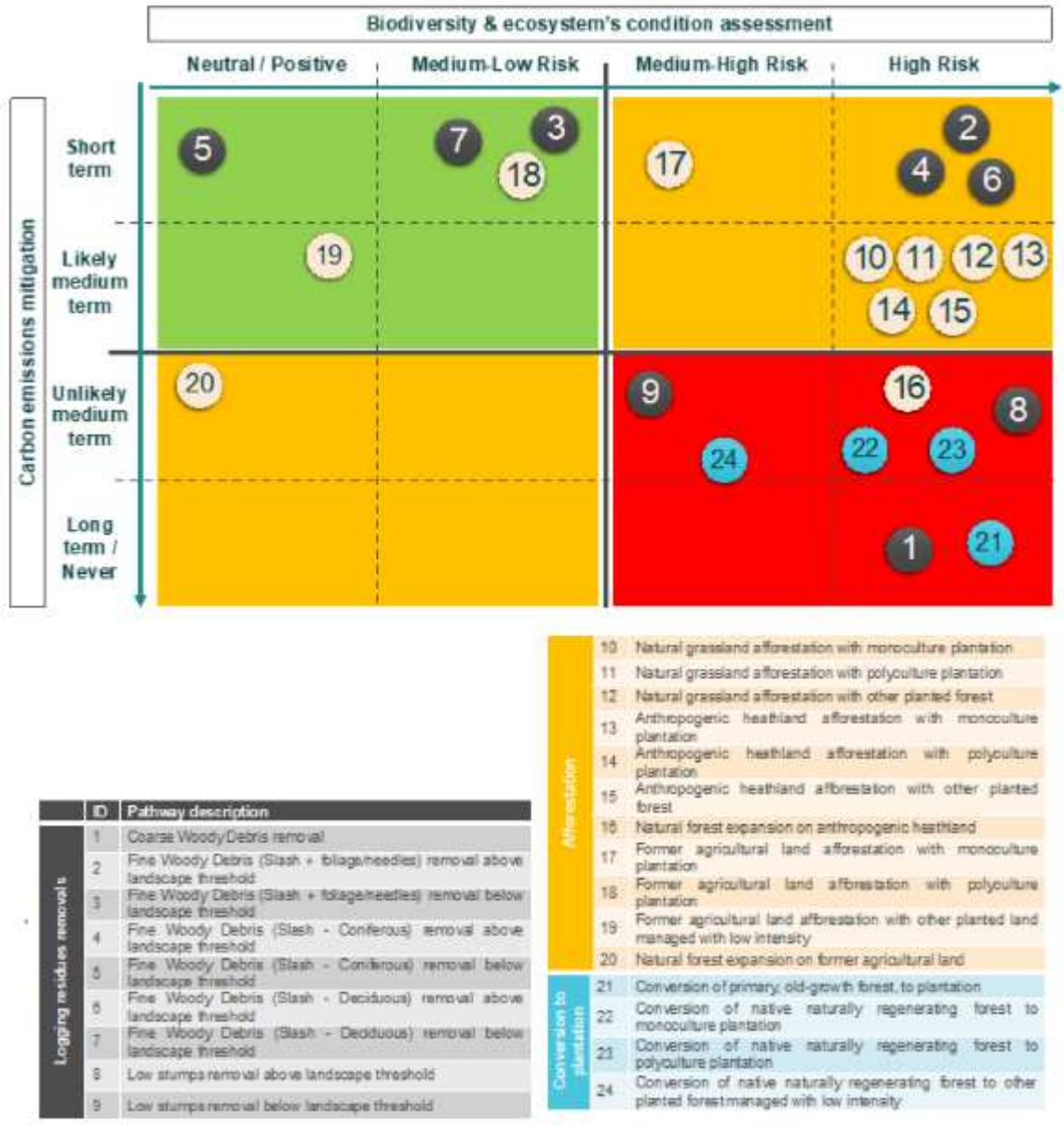
[130] Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719

improve tracking and reporting of a crucial climate policy resource, and the report identifies also Earth observation (remote sensing, and Copernicus services) as a suitable and potent tool to address this. The report also suggest to extend the REDII biomass sustainability criteria for heat and power to smaller scale installations below 20 MW to address this data gap and avoid the risk of leakage of sustainable biomass from large to small scale uses.

The JRC report provides detailed assessments of a wide variety of pathways for biomass sourcing. Summarised in the figure below, these show, on the one hand, that it is indeed possible to highlight pathways that can both reduce greenhouse gas emissions in the short term while not damaging, or even improving, the condition of forest ecosystems. For example, afforestation on former agricultural land with mixed species plantations or with naturally regenerating forests would enhance the terrestrial sink even before producing biomass for energy and thus would contribute to climate change mitigation, while at the same time improving ecosystems' conditions.

On the other hand, several pathways are categorized negatively on both biodiversity and climate counts, and should be discouraged. In this respect, it can be highlighted that the conversion of natural and old growth forests to plantations aiming to provide wood for bioenergy would be extremely negative for local biodiversity, and at the same time it would provide no carbon mitigation in the short-medium term. Similar considerations are valid also for the conversion of naturally regenerating forests to high-intensity management plantations: the impact on local biodiversity is highly negative while, even though wood production might increase, the benefits in terms of carbon mitigation are only accrued in the medium to long term.

*Figure 90 - Qualitative assessment of the archetype pathways based on their climate and biodiversity impacts. Black symbols represent pathways referring to 'logging residues removal' intervention, yellow symbols refer to pathways for 'afforestation', and blue symbols refer to 'conversion to plantation' interventions. Uncertainty ranges are placed where payback time for carbon emissions could not be placed within a single one of the already broadly defined levels. The position of the interventions within each sub-section is arbitrary. (Source: Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719, Fig. 42)*




According to the JRC analysis, wood-based bioenergy production is, to a large extent, based on secondary woody biomass (forest-based industry by-products and recovered post-consumer wood), which makes up almost half of the reported wood use (49%). Nevertheless, primary woody biomass (stemwood, treetops, branches, etc. harvested from forests) makes up at least 37% of the EU input mix of wood for energy production (and the remaining 14% is uncategorised in the reported statistics).

Considerable inconsistencies in reported data are identified: it is estimated that in the EU, the amount of woody biomass used exceeds the total amount of reported as sources by more than 20%, with

large differences among Member States[132]. This identified gap also highlights a specific need to improve tracking and reporting of a crucial climate policy resource, and the report identifies also Earth observation (remote sensing, and Copernicus services) as a suitable and potent tool to address this. The report also suggest to extend the REDII biomass sustainability criteria for heat and power to smaller scale installations below 20 MW to address this data gap and avoid the risk of leakage of sustainable biomass from large to small scale uses.

### DETAILS ON ADMINISTRATIVE COSTS – THE CASE OF A 15 MW BIOMASS CHP PLANT

Administrative costs – the case of a 15 MW biomass CHP plant

A 15 MW (input) CHP biomass plant is able to produce 4 MW of electricity and 9 MW of heat. Assuming a load of 50% (i.e. the plant runs at full power for 50% of the time) and a conversion efficiency of 3.5 tonnes of oven-dry biomass per MWh, the plant would need 19,000 tonnes of fuel per year133. At an indicative price for woodchips at €120 per tonne, the plant would have annual fuel cost of €2.3 million per year.

In order to demonstrate compliance, an installation has to keep records of purchases of certified woodchips sufficient to cover the fuel needed to produce the MWh output generated over a certain period. The installation has then to be audited and certified, which means an independent third party has to verify that this information is available and satisfies the criteria.

Audit cost may vary between €5,000 and €10,000134 per year, while working hours spent on administrative tasks depend on a number of factors. For example, how many fuel shipments the plant requires per year, the extent to which software allows the system to be automated etc. However, these are expected to be limited: in 2017135 these were estimated to be 64 one-off and 36 hours per year.

Besides direct costs, the plant may have to face increased fuel costs, as it has to ensure the purchase of certified fuelwood. Some cost of certification would accrue for each step in the supply chain, but they may vary according to the trader (for example, a trader that already supplies certified wood or currently supplies plants above 20 MW is likely to have in place the appropriate process so that its cost increase will be limited to the associated quantities).

[133] This is equivalent to 380 truck-trailers (largest available) per year. https://metsateho.fi/wp-content/uploads/L2.2.-Laitila.pdf

[134] Based on various estimates. For example, EC (2016) *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems*, reports energy audit costs in manufacturing between €9,000 and €30,000, but these will involve far more complex assessments than those envisaged for compliance with RED criteria.

[135] Sustainable and optimal use of biomass for energy in the EU beyond 2020, May 2017

## ANNEX 10: CHANGES TO DIRECTIVE 98/70/EC

Technical specification for fuels used in road transport are regulated in Directive 98/70/EC, so-called Fuel Quality Directive (FQD) to protect health and the environment and ensure vehicle compatibility across the EU. Increasing the biofuel blend above certain levels may affect the functioning of engines and emissions control systems, or increase maintenance requirements, particularly in older vehicles.

The FQD therefore requires the placing on the market of a protection grade for petrol with a maximum oxygen content of 2.7% and ethanol content of 5% (i.e. E5) until 2013, with allowance for Member States to continue this requirement for a longer period if considered necessary. Based on available information there is no E5 protection grade enforced in 15 Member States, while there is in 6 Member States with 2 indicating a future date for its removal (in 2022 and 2024 respectively); no information has become available for the remaining 6 Member States.

No similar requirement for a protection grade is made for diesel. While B7 (7% FAME) is currently the most commonly available grade, certain Member States have or are considering the marketing of B+ (higher than 7% v/v blend).

### Opportunity to revise legal provisions

The technical limits on oxygenates and ethers blended in gasoline and the technical limits on FAME blended in diesel fuel as well as standards set of other parameters which can be affected with increased alternative fuel blend components may limit the range of options available to attain higher ambition levels with respect to the incorporation of renewables in the road transport fuel mix.

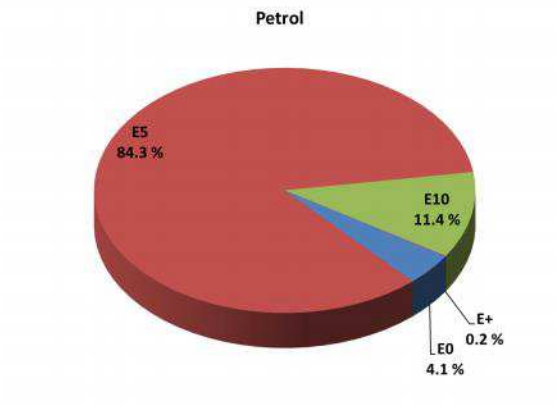
In the context of the revision of the REDII and its increased ambition level with respect to the incorporation of renewable components in transportation fuels, it is relevant to assess if changes are necessary for protection grades for petrol and diesel, considering blends which may be taken up between 2021 and 2030. This includes consideration of the number of vehicles in the EU fleet for which a protection grade may be needed and what the costs would otherwise be for owners of incompatible vehicle owners.

Costs to suppliers as a result of multiple grades of fuels being marketed across the EU, and reflecting on whether a change to the FQD in this respect will have EU added value, in terms of the objective for promoting a single market are equally relevant. Also, it is worth noting that as fuel suppliers benefit from marketing the minimum number of grades of fuel, there is risk that the protection grade is used on a wider scale than just the vehicles that need it (as it is the case currently with E5 particularly in some MS).

### Fuels marketed in the EU

Nearly 96% of the petrol sold in the EU in 2018 contained bioethanol: 84.3 % was of the product type E5 (i.e. up to 5 % ethanol content by volume and in which the ethanol is derived from biofuels or is of biogenic origin), 11.4% was E10 (i.e. up to 10 % ethanol content by volume) and 4.1 % was E0 (no ethanol content). Only 0.2 % of petrol was E+ (i.e. > 10 % ethanol content by volume). This refers mainly to E85, used in engines modified to accept a higher content of ethanol. Such flexi-fuel vehicles (FFV) are designed to run on any mixture of petrol and ethanol with up to 85 % ethanol by volume.

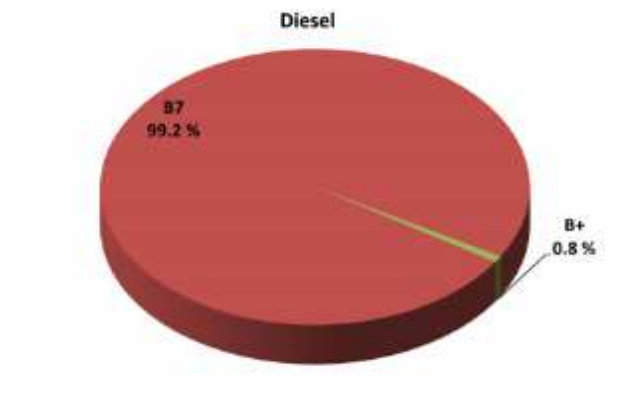
*Figure 91 - Petrol sold in the EU in 2018*




*Source: Eionet report - ETC/CME 9/2019 October 2020 Fuel quality monitoring in the EU in 2018, Fuel quality monitoring under the Fuel Quality Directive*

All diesel sold in the EU contained biodiesel: 99.2 % was of the B7 product type (i.e. containing up to 7 % fatty acid methyl esters, FAME) and 0.8 % was of the B+ product type (i.e. containing more than 7 % FAME).

*Figure 92 - Diesel sold in the EU in 2018*




*Source: Eionet report - ETC/CME 9/2019 October 2020 Fuel quality monitoring in the EU in 2018, Fuel quality monitoring under the Fuel Quality Directive*

Since 2015, diesel sold in France has been B8 or B10. Lithuania's main diesel grade contains 8% biofuel. In the FQD Evaluation the automobile industry and fuel suppliers argued this constitutes fragmentation of the single market. They further requested clear labelling of the B8 blend and the supply of B7 as a protection grade for vehicles that are not compatible. The FQD REFIT evaluation staff working document has noted that not offering a B7 protection grade goes against the objective of the FQD to ensure fuel-engine compatibility.

According to PRIMES MIX scenario gasoline and diesel fuel consumption is expected to reduce in 2030 compared to 2020. The respective shares of the bio-based components are nevertheless expected to increase, passing from 6% in 2020 to 8% in 2030 in gasoline, and from 8% to 10% in diesel blends.

*Table 53 - EU27 petrol and diesel fuel consumption; Source: PRIMES/ Prepanl / EU27noUK:Green Deal 55% carbon taxation COVID scenario /transport*

**EU27 Petrol consumption (ktoes)** **EU27 Diesel fuel consumption (ktoes)**

| | **2020** | **2030** | | **2020** | **2030** |
|---|---|---|---|---|---|
| Petrol | 56956 | 48125 | Diesel fuel | 158660 | 146703 |
| *of which biofuel* | *3255* | *3766* | *of which biofuel* | 12624 | 14856 |
| *% biofuel* | *6%* | *8%* | *% biofuel* | *8%* | *10%* |

**Initial considerations**

Bio-ethanol

For bio-ethanol blends where the EU legal obligation for the E5 protection grade is no longer in force since 2013 and the currently allowed maximum E10 blending is far from being reached across the EU, a revision of the reference fuel for petrol to be able to incorporate higher volumes of bio-ethanol blend does not seem to be justified in the 2030 perspective.

In support of this, the following evidence is considered as relevant.

- A 2017 report for the European Commission noted that most post-2003 vehicles are E10 tolerant **Invalid source specified.**.
- Most post-2003 vehicles are E10 tolerant[136]. The proportion of pre-2003 vehicles in circulation in 2020 is 1.3 to 6.8% depending on MS. ACEA also publishes a regularly updated comprehensive list[137] of vehicles compatible with E10 fuel with post-2011 vehicles suggested by manufacturers to be E20 tolerant.
- ACEA reports that the average age of a passenger car in the EU is 10.8 years old[138]. Some Member States have much older vehicle fleets than others: Lithuania (16.9 years), Estonia (16.7 years), Romania (16.3 years) Greece (15.7 years), and so changes to protection grades could disproportionately impact some Member States. However, Romania and Estonia already market E10 widely[139]. In the case of Estonia, E10 holds 45% of the petrol market share, while E10 is 100% of the petrol sold in Romania.
- Based on vehicle fleet projections of the PRIMES-TREMOVE model to 2030 and due to natural fleet turnover, by 2030 there will be only a small number of vehicles requiring E5, i.e. vehicles aged 27 years or older in 2030.
- The cost of retrofitting is between €200[140] and €550[141]. Small numbers of vehicles of this age will still be in circulation, particularly in the case of classic car enthusiasts. For vintage cars such as these, compatible petrol supply may be considered via special interest groups rather than in the general market.

[136] https://op.europa.eu/en/publication-detail/-/publication/ec1f67bd-5499-11e7-a5ca-01aa75ed71a1
[137] https://www.acea.be/uploads/publications/ACEA_E10_compatibility.pdf
[138] https://www.acea.be/uploads/publications/ACEA_Report_Vehicles_in_use-Europe_2019.pdf
[139] https://www.epure.org/about-ethanol/fuel-market/fuel-blends/
[140] https://op.europa.eu/en/publication-detail/-/publication/ec1f67bd-5499-11e7-a5ca-01aa75ed71a1
[141] https://www.gov.uk/government/consultations/introducing-e10-petrol

- The majority of stakeholders[142] consulted in 2020 indicated that no problems would be caused by the removal of the E5 protection grade, particularly in the case of vehicle manufacturers and fuel producers/suppliers.
  Stakeholders were also asked what they believe to be the appropriate protection grade for petrol by 2030, if any: the majority believe E10 would be an appropriate protection grade in 2030. One stakeholder group which has a differing view to this are fuel producers or suppliers, for which the majority believe that no protection grade is needed in 2030.

Diesel fuels and bio-based components

The reasoning differs for diesel fuels and relevant bio-based components. Whereas part of the biodiesel component is made up by hydrogenated vegetable oils (HVO), which are drop-in fuels not subject to the same technical limitations as FAME for vehicle compatibility, limiting reference diesel fuel to B7 could be perceived as a barrier to achieving GHG reduction targets, considering that practically the entire EU supply of diesel was B7 in 2018.

Sustaining the market uptake of B10 would require a B7 protection grade, which is currently not provided for in the FQD as noted above, but was already flagged as relevant in the FQD REFIT in the interest of vehicle compatibility and functioning of the single market functioning.

The FQD allows Member States to market diesel blends that have a FAME content higher than the 7% specified in the FQD. CEN has developed standards for higher diesel blends, including B10. When comparing technical parameters for diesel fuels regulated by FQD, the only difference with EN590 for B7 and EN16734 is the content of FAME, which increases from 7% v/v to 10% v/v.

*Table 54 - Standards of different diesel blends*

| Property | Units | FQD | B7 | B10 |
|---|---|---|---|---|
| Standard | | | EN590 | EN 16734 |
| Density @15°C | kg/m3 | <845 | 820-845 | 820-845 |
| Cetane Number | | >51 | >51 | >51 |
| PAH | %m/m | <8.0 | <8.0 | <8.0 |
| Sulphur Content | mg/kg | <10.0 | <10.0 | <10.0 |
| Manganese Content | mg/l | <2.0 | <2.0 | <2.0 |
| Distillation | | | | |
| - 95%V/V Recovered at | °C | <360 | <360 | <360 |
| Fatty Acid Methyl Ester (FAME) | %V/V | <7.0 | <7.0 | <10 |

[142] The stakeholder consultation was performed through Contract no. 340201 2019 815556 ETU CLIMA.C.4

**B10 in the stakeholder consultation**

Stakeholders[143] expressed a largely positive response to expectation by 2030 of FAME blends moderately beyond current limits, (i.e. 8-10%). There were also a number of responses indicating positively that blends of higher level will be used, with 29% of respondents indicating blends of 11-20% will be used (60% of respondents provided an input on this range).

In lower blends of fuels, i.e. up to 10% biofuel, FAME is the most dominant fuel type responded by stakeholders, followed by a combination of FAME and HVO. In blends of 11-20%, HVO is the type of fuel most expected to be used in 2030. Next to FAME and HVO, most respondents that did specify other renewable fuels may be added to diesel blends in 2030, mentioned that synthetic diesel (i.e. PtX, E-fuels) could be expected to be used in all diesel blends. A fuel producers' association also mentioned the possibility of DME in diesel blends of 1-7% renewable content.

Some fuel producers suggest FAME in the 8-30% range could also be used by all vehicles, while others specify that these vehicles would have to be identified as B10, B20 or B30 compatible; many respondents argue that the use would likely be limited to captive fleets, heavy-duty vehicles or bus fleets.

France and one unidentified Member State note that diesel blends in the 8-10% band are likely to be used in all vehicles by 2030, while one further Member State mentions that this blend could be used if it was allowed under the FQD. Ireland also noted that it expects diesel blends with 11-20% bio or renewable content to be used by all vehicles by 2030.

**Vehicle compatibility with B10 fuel grade**

There was inconsistency in the views of stakeholders on the compatibility of the existing fleet with B10. Most of the respondents that argued there should be no protection grades argued that setting protection grades would hinder the development of the biofuel market and would slow the progress towards meeting the GHG targets. With respect to B10 fuel specifically, it was mentioned that vehicle manufacturers would need to advise more frequent service intervals to change engine oil, due to possible dilution of engine oil with FAME

The vehicle producers association ACEA published a list[144] of passenger cars compatible with the B10 diesel fuel in 2018 **Invalid source specified.**. The list indicates that not all vehicles were marked as being compatible with B10. For example, all Citroën and Peugeot vehicles introduced after 2000 and Renault vehicles with type-approval Euro 5 or higher are compatible. For other car manufacturers, ACEA's list indicates that only certain vehicles are compatible.

A more recent list of B10 compatible vehicles prepared by biofuel producer associations AGQM and MVaK was published in 2020 **Invalid source specified.**. The list highlights that many vehicles that are marked as compatible to run on B10 do so outside Europe. Next to those approved in the ACEA list, the AGQM and MVaK list also notes that all BMW, Dacia and Opel vehicles with type-approval Euro 5 or higher are compatible with B10.

The vehicle manufacturers noted above (ACEA and MVaK lists) comprise one third of the diesel vehicle market in 2019 and it is likely higher in reality, meaning that the proportion of compatible

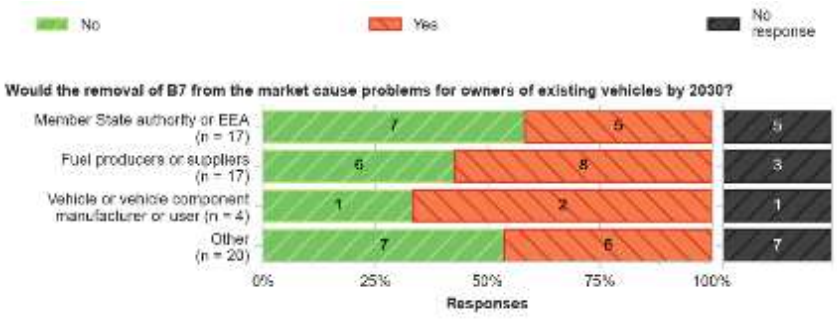
[143] The stakeholder consultation was performed in the study "Technical assessment of transport fuel quality parameters", Contract no. 340201 2019 815556 ETU CLIMA.C.4

[144] https://www.acea.be/uploads/publications/ACEA_B10_compatibility.pdf

vehicles should exceed this, as not every vehicle model marked as B10 compatible could be identified. One vehicle manufacturer organisation noted that all their vehicles sold after 2000 are compatible in the stakeholder questionnaire. Another organisation indicated all vehicles with Euro 5 type-approval or higher. Based on this information, it is assumed that potentially 50% of new vehicles in 2020/2021 may have compatibility issues with B10 fuel.

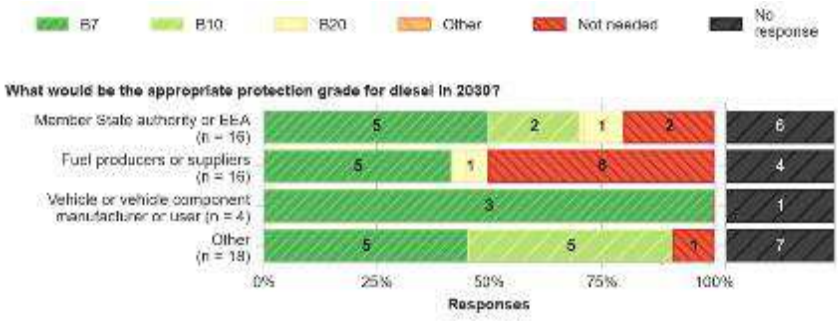
The expectation by stakeholders of consequences of a removal of B7 from the market is split, as shown in the table below: exactly half of the stakeholders responding to the survey believed that no problems would be caused by such a removal, while the other half believed problems would be caused.

*Figure 93 - Stakeholder responses to the question: "would the removal of B7 from the market cause problems for owners of existing vehicles by 2030?"*




When asked what an appropriate protection grade for diesel in 2030 would be, the responses indicate that half of stakeholders believe a B7 protection grade should be introduced, as shown in the table below. A quarter of respondents, mostly from the fuel producers and suppliers group, believe that no protection grade for diesel is required. Some respondents (19%) indicated that B10 would be the appropriate protection grade. All vehicle manufacturers responding to the question indicated that a B7 protection grade is appropriate.

*Figure 94 - Stakeholder responses to the question: "what would be the appropriate protection grade in 2030?"*




A protection grade for diesel would only be required should adoption of B10 become more widespread. In response to such an increase to B10, it is assumed that all manufacturers would adapt their new vehicles to be compatible, resulting in all vehicles registered between 2025 and 2030 being compatible.

| Vehicle age in | 2030 Number of vehicles (000s) | | Proportion of vehicles not |
|---|---|---|---|
| | Cars | LDVs | |

2030 [redacted] compatible with B10

*Table 55 - European Fleet of B10 non compatible diesel cars and light duty vehicles (LDVs) in 2030 by age according to PRIMES-TREMOVE model and fuel compatibility (000's of Vehicles)*

| | | | |
|---|---|---|---|
| **0-4 years** | 18721 | 4581 | 0% assumed* not to be compatible |
| **4-9 years** | 23305 | 4713 | Approximately 10% of vehicles assumed* not to be compatible |
| **9-14 years** | 22989 | 6395 | Approximately 50% of vehicles estimated not to be compatible, based on information from literature and stakeholders |
| **14-19 years** | 9695 | 3020 | Approximately 70% of vehicles estimated not to be compatible , based on information from literature and stakeholders |

*estimated, based on the assumption that new vehicles will be adapted to be compatible with B10 in response to increased marketing of B10.

Based on the above, 28% of the combined car and LDV fleet is assumed as not compatible with B10 in 2030. Economic impacts are assessed based on this assumption.

**Economic impacts**

Cost of Vehicle Upgrades or Retrofits

There would be economic impacts for some vehicle owners without B7 protection grades for diesel (for FAME content). Owners of non-compatible vehicles would need to replace their vehicle with a newer, compatible model. Costs are calculated on the basis of owners replacing their vehicle earlier than the end of life, leading to lost residual value of the vehicle and an effective cost associated with incurring the replacement costs earlier than they otherwise would. This effective cost is due to the difference in present value of the cost, calculated using a social rate-of-time preference 4% annual discount rate.

*Table 56 - Cost of Vehicle Upgrades in Absence of Protection Grade (Vehicles not compatible with B10) 2015 Price Year*

| Vehicle type | Lost residual value of vehicles | Cost due to earlier vehicle purchase | Total cost |
|---|---|---|---|
| **Cars (Diesel)** | **€62.1bn** | **€110bn** | **€172.4bn** |
| **LDVs (Diesel)** | €22.7bn | €43.4bn | €66.1bn |

| | | | |
|---|---|---|---|
| **Total (Diesel)** | | | €238.5bn |

Source: "Technical assessment of transport fuel quality parameters", Contract no. 340201 2019 815556 ETU CLIMA.C.4

Costs for Fuel Suppliers

The introduction of a B7 protection grade for diesel could lead to some filling stations marketing an increased number of fuel grades and which may require making associated investments in storage and refuelling infrastructure. An estimate for the investment cost of around €100,000 for a filling station to market an additional grade of E85 in 2015 is made in **Invalid source specified.**. Europe's Independent Fuel Suppliers (UPEI) provided a higher cost in the stakeholder survey, indicating that the introduction of additional marketed grades could cost between €200,000 and €2,000,000 per filling station. Beyond investment in additional tanks, pumps, hoses, store management systems and electronic pricing information at the retail location, new grades would also affect the cost of storage & handling (S&H). A lot of factors, such as the volume of each grade, if it is a blended or straight product or if it can be blended in a truck will affect the costs. Furthermore, truck usage would also become less optimised if additional blends were required, which could lead to additional distribution costs.

Depending on market uptake of higher biodiesel content in diesel, the share of filling stations required to make such an investment may differ. Here we consider three scenarios: a) 10% of filling stations, b) 50% of filling stations and c) 100% of filling stations. Based on the cost data gathered from the literature and stakeholder survey, a cost estimate of €200,000 is used per filling station for marketing an additional grade of fuel. There were 75,396 active filling stations in the EU in 2018 Invalid source specified.. We assume the same number of active filling stations in 2030. As shown in the table below. the estimated cost to fuel suppliers is between €1.5 Billion and €15 Billion.

*Table 57 - Estimated cost of supplying additional grades for scenarios of different % of petrol stations marketing additional B7 protection grade 2015 Price Year*

| Scenario | Number of filling stations | Estimated cost (million €) |
|---|---|---|
| **Scenario a) – 10%** | 7,540 | 1,508 |
| **Scenario b) – 50%** | 37,698 | 7,540 |
| **Scenario c) – 100%** | 75,396 | 15,079 |

In different Member States, ownership structures of filling stations varies, with some being dominated by a small number of larger companies (Germany, Greece, Italy), while in others ownership is largely by smaller independent retailers (Poland) **Invalid source specified.**. Smaller, independent retailers are likely to have less available funds for investing in additional infrastructure and would be disproportionately affected by the need to market an additional grade of fuel. As an alternative response, these retailers may choose to market only the protection grade, leading to reduced biofuel uptake (See Environmental Impacts).

**Impacts on the Single Market**

Protection grades can negatively impact the EU single market. If the protection grade is optional, then some Member States will choose to adopt it and some will not. In countries where it is adopted, the protection grade may become the dominant or only fuel that is sold. Other Member States may choose to require E10 instead, due to greenhouse gas targets. This can therefore lead to a situation of increased market fragmentation. This theoretically can increase costs for producers as there is less economy of scale and more fragmented grades across Europe.

This fragmentation can also affect owners of vehicles requiring the protection grade, in the event of driving across borders of different Member States.

**Environmental impacts**

Greenhouse Gas and air pollutant emissions

A protection grade can reduce uptake of biofuels and prevent greenhouse gas emission reductions. The costs of marketing multiple grades of fuel means that some filling stations, particularly smaller stations or those independently owned, may need to market only the protection grade, therefore reducing biofuel uptake and greenhouse gas emission savings.

In the PRIMES-TREMOVE modelling, a scenario has been modelled[145] for the widespread uptake of B10 without protection grades, with impacts calculated relative to a baseline which includes no FAME protection grade. The impacts of a possible B7 protection grade is therefore calculated in the context of reducing the potential benefits. This impact depends on the extent to which protection grade fuels are marketed. Impacts are estimated for two scenarios: firstly, where protection grade fuels are only used by vehicles that require them. In the case of diesel and B7 protection grade, it is estimated that approximately 28% of the car and LDV fleet is not B10 compatible in 2030. Secondly, where protection grades are utilised by a larger proportion of the fleet: the protection grade take up is assumed to be 70%.

The table below shows the estimated emissions impacts of a B7 protection grade in the form of reduced benefits. It reflects the impacts relative to the PRIMES modelling scenario, where in the absence of a B7 protection grade there is total fleet uptake of a diesel blend with 10% FAME and 10% HVO. As such, these impacts are an upper estimate of the emissions impacts of the protection grades given the ambitious nature of the PRIMES modelling scenario.

*Table 58 - Emissions Impact of Protection Grades*

| Protection Grade (Fuel) | Percentage Of Fleet Using Protection Grade | NOX Emissions impact relative to PRIMES-TREMOVE Scenario | SO2 Emissions impact relative to PRIMES-TREMOVE Scenario | CO2 Emissions impact relative to PRIMES-TREMOVE Scenario |
|---|---|---|---|---|

[145] "Technical assessment of transport fuel quality parameters", Contract no. 340201 2019 815556 ETU CLIMA.C.4

| | | | | |
|---|---|---|---|---|
| B7 (Diesel) | 28% | 4.3 kt | 16.4t | 9,602 kt |
| B7 (Diesel) | 70% | 10.8 kt | 41.1t | 24,006 kt |

**Conclusions**

In the context of the revision of the REDII and its increased ambition level with respect to the incorporation of renewable components in transportation fuels, it is relevant to assess if changes are necessary for protection grades for petrol and diesel, considering blends which may be taken up towards 2030.

For bio-ethanol blends where the EU legal obligation for the E5 protection grade is no longer in force since 2013 and the currently allowed maximum E10 blending is far from being reached across the EU, a revision of the reference fuel for petrol to be able to incorporate higher volumes of bio-ethanol blend does not seem to be justified in the 2030 perspective.

For bio-based components in diesel fuel, limiting reference diesel fuel to B7 limits available options to attain higher targets in the revised REDII, considering that practically the entire EU supply of diesel was B7 in 2018.

Sustaining the market uptake of B10 would require a B7 protection grade, which is currently not provided for in the FQD as noted above, but was already flagged as relevant in the FQD REFIT in the interest of vehicle compatibility and functioning of the single market functioning.

The introduction of an EU-wide B7 protection grade for 7% FAME in diesel is recommended due to the proportion of vehicles (potentially 28%) not compatible with B10 expected to be present in the fleet by 2030. It is considered necessary by vehicle manufacturers and half of fuel supplier stakeholders that engaged in the consultation for this study. However, the extent to which the non compatibility exists is disputed by some stakeholders. Without the protection grade, owners of incompatible vehicles would incur costs of early vehicle replacement, with relatively higher incidence in Member States with older average fleet age, which are also among the Member States with lower than average GDP per capita.

The disadvantage of introduction of a B7 protection grade is that it may lessen the increase in uptake of biofuels and consequently lead to lower than otherwise environmental benefits. There could also potentially be additional costs for fuel suppliers resulting from marketing of multiple diesel grades, depending on whether the protection grade must be available in all filling stations or only a smaller proportion, for example those above a certain size.

In the case of bio-ethanol in petrol, the E5 protection grade is assessed as irrelevant with E10 as reference fuel. It is therefore concluded that no legal revision is needed for bio-ethanol content in traded petrol at this stage.

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