Opinion of the European Economic and Social Committee on the Role of carbon removal technologies in decarbonising European industry

(own-initiative opinion)

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1. **Conclusions and recommendations**

1.1. The EESC reiterates its strong support for the Green Deal commitments and for reinforcing strategic autonomy in energy provision and industrial leadership.

1.2. The effects of the ongoing war in Ukraine on the availability of energy and raw materials cannot be disregarded, and the European Semester must monitor the situation.

1.3. The green transition in the manufacturing industry needs a basis of a sufficient, proper mix of renewable energy for electrification and for the production of green hydrogen to succeed. Carbon Dioxide Removal technologies (CDRs), Carbon Capture and Storage (CCS) and Carbon Capture and Use (CCU) will help the industry to achieve climate neutrality. Deployment of renewable energy across Europe is necessary to achieve the Green Deal targets.

1.4. Decarbonisation will require a deep transformation of industrial activities (in the next 30 years). Although many low-carbon technologies already exist, their technology readiness levels (TRL [1]) are low. Ambitious technology roadmaps will be needed to upscale and widely deploy these breakthrough technologies, and the EU must promote innovation through the Climate and Innovation Funds.

1.5. Development of technologies and education and reskilling of the workforce is therefore vital for the green transition in the manufacturing industry. Social dialogue at both European, Member State and regional level should support awareness, acceptance and support of a green and just transition in the industry. Capability building and projects to define key skills will be essential in order to ensure an effective industrial transition that leaves no one behind.

1.6. Increasing the use of alternative feedstocks — in particular sustainable biomass — has the potential to contribute to sustainable removal of carbon from the atmosphere by promoting the sustainable management of productive land (farm and forest land) and the use of biomass in long-lived products that further prolong the removal benefit. Additionally, it would help to reduce the EU's dependence on imported feedstocks and resources.

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[1] TRL: Technology Readiness Levels are different points on a scale used to measure the progress or maturity level of a technology.

1.7. The EESC calls for the competitiveness of European industry to be preserved: the EU is a pioneer in CO_2 emissions reduction, but it needs other players to follow its climate ambition. As the climate crisis is global, European Union diplomacy must step up its efforts to effectively persuade third countries to scale up their efforts to fight it. Regardless of the ambitious EU policy objectives, the EU will increasingly become a pioneer for the decarbonisation of industries thanks to its political support and to companies' and their workers' practical knowledge of industrial capacities, the necessary technologies and how to anticipate change, enabling practical measures to be taken accordingly.

1.8. Keeping a sound industrial base within the EU will secure prosperity, quality jobs and a commitment to fighting climate change for European society. European industry must invest in Europe, with a proper regulatory framework, in both R&D&I and plant and equipment, in order to keep its competitive position.

2. **General comments**

2.1. The European climate law has set an ambitious emission reduction target for 2030 while confirming the climate neutrality objective for 2050. In order to reach the European Union's goal, all greenhouse gas (GHG) emissions activities need to be analysed and pathways to net-zero emissions by around 2050 need to be identified.

2.2. Manufacturing industries are responsible for 20 % ([2]) of European emissions. The CO_2-intensive manufacturing industries in Europe are the iron and steel, cement, chemical and petrochemical, pulp and paper, fertiliser, glass, ceramic, oil refineries and non-ferrous metal (mainly aluminium) industries. The industrial sector's GHG emissions include carbon dioxide (CO_2) from energy use, from non-energy uses of fossil fuels and from non-fossil fuel sources, as well as non-CO_2 gases.

2.3. The green transition of the manufacturing industry is vital in order to comply with the European climate law. There will be a transition in technologies and, following that, changes in working methods, skills and competencies in the industries. However, demand-side measures to promote the uptake of low-carbon products and new business models (industrial symbiosis, circularity, demand response) will also be needed.

3. **Manufacturing industry on the pathway to climate neutrality**

3.1. This own-initiative opinion focuses on industrial sectors under the ETS. Energy utilities, transport and buildings are not, therefore, covered.

3.2. In addition to the decarbonisation challenge, improving energy efficiency is imperative for every single industrial sector. Although it will not be enough to decarbonise European industry, energy efficiency can significantly reduce emissions from energy consumption. There will be a shift from fossil fuels to non-greenhouse gas emitting technologies, mostly renewable energy. Utilities and public authorities are accountable for the energy transition from fossil fuels to non-emitting technologies.

3.3. In relation to the decarbonisation challenge, industries could be classified as follows:

— sectors that need to radically change their production process: steel (integrated route), fertilisers and chemical industry;

— sectors that need to change the energy vector in the production process: steel (electric arc furnaces), glass, ceramic, paper, etc.;

— 'hard to abate sectors', such as the cement sector, which must capture and store (or use) the CO_2 emitted during the manufacturing process to become climate neutral;

— sectors that may take advantage of Carbon Capture and Utilisation technologies, to develop high value-added products, such as oil refineries and the chemical and petrochemical industries.

([2]) European Environment Agency.

3.4. Industrial high-efficiency cogeneration (CHP ([3])) will certainly contribute to more energy efficiency, but it cannot decarbonise the industry. Alternatively, using low enthalpy heat from the industry for district heating would be another way to raise overall energy efficiency, and it could maybe be credited during the transition path to full decarbonisation.

3.5. Carbon Dioxide Removal (CDR) technologies remove CO_2 already emitted from the atmosphere, thus creating 'negative' emissions. CCS-related technologies, such as bioenergy with carbon capture and storage (BECCS) and direct air capture and storage (DACCS), are an important part of the portfolio of negative emissions technologies. However, despite their climate change mitigation potential, these technologies are currently only at the demonstration stage. Other CDR technologies comprise activities enhancing natural CO_2 sinks, such as afforestation and reforestation, and are outside of the scope of this opinion.

The challenge of the future of CDR in the manufacturing industry is to find a balance where carbon capture and storage is a mitigation option alongside other carbon reduction and removal technologies. GHG reductions and removal must be aligned with the Paris Agreement and the European climate law. CCS can enable the EU to proceed at the necessary pace with GHG removal, but the goal must be to avoid carbon storage in the long run.

3.6. Hydrogen produced by using renewable energy (green hydrogen) seems to be the cross-sectoral answer to the decarbonisation processes. For example, there is a project in Sweden aiming to eliminate greenhouse gas emissions from steel production by using renewable hydrogen. In Finland, a project will demonstrate ways of producing blue and later green hydrogen and capturing CO_2 and permanently store it in the Baltic Sea.

4. **Manufacturing industry on the road to decarbonisation**

4.1. Of all European industries, we are focusing on the sectors with high potential for improvement and impact on reducing European CO_2 emissions. In the manufacturing industry, the focus is on sectors which have more challenges to overcome in order to decarbonise. This opinion focuses on the steel, cement, chemical and petrochemical, oil refineries, pulp and paper, fertiliser, glass and ceramic industries.

4.2. Before describing technologies that could have an impact on the reduction and removal of carbon dioxide emissions, we have to consider turning from fossil fuel-derived energy sources to other non-emitting sources of energy and other renewable sources. These sources could be wind power, photovoltaic and thermo-solar power, hydropower, geothermal energy, biomass and biofuels.

4.3. There are some industries that would have to adopt existing or new technologies in their processes in order to achieve zero emission of GHGs in order to move to a climate neutral society. Depending on each industry and their current CHG emissions, they may need to take a single or several steps.

4.4. This first step could seem to be 'just' a change in the production/sourcing part of the process. In many other situations, further research and development may be needed, for example to adapt current natural gas burners to hydrogen or to use heat pumps. In addition, considerations regarding the interplay between hydrogen and the materials or products should be addressed too.

4.5. Steel industry:

The challenge for the traditional steel industry (integrated route, which requires iron ore reduction) has already led to several new technological approaches being introduced, which now focus on replacing blast furnaces with electric arc furnaces fed with direct reduced iron (DRI) produced using green hydrogen. Other alternatives already explored rely on CCS technologies, but they cannot meet the GHG reduction target. Iron ore electrolysis could emit up to 87 % less CO_2 than the current integrated route (if the electricity supply is fully decarbonised). Hydrogen plasma reduction aimed at zero CO_2 emissions. In fact, hydrogen steelmaking could emit up to 95 % less CO_2 than the current integrated route (if it uses fully decarbonised electricity), but due to the energy lost during hydrogen production this would increase the industry's energy consumption.

([3]) CHP: combined heat and power.

Steel produced in electric arc furnaces emits just 14 % of the GHG emissions from the integrated route and its main challenge is to replace natural gas in the rolling furnaces with green hydrogen or induction electricity.

CCU (using the waste gases of blast furnaces) can reduce emissions by up to 65 % if fully deployed (CO_2 reduction also depends on the full lifecycle of the resulting chemical products). Several are at a more advanced stage of development — the Steelanol demonstration plant (currently under construction — TRL 9) uses waste gas to produce bio-ethanol and the Carbon2Chem project (TRL 7-8) aims to use waste gas as a raw material for chemicals.

4.6. Cement industry:

Only 37 % of emissions in the cement industry come from fuels, while the remaining 63 % of emissions are the result of a chemical reaction of the raw material (process emission). The use of fuels derived from renewable sources (biomass or hydrogen) will therefore reduce emissivity by a maximum of 35 %. Technologies are currently being tested that may allow for the future capture and management or storage of CO_2 (amine method and calcium loop). Another way to reduce emissions is to develop what are known as low-clinker cements, which currently have a TRL of 5-7. Such cements have an emissivity up to 30 % lower than pure Portland cements.

4.7. Chemical industry:

In the chemical industry, the electrification of production processes such as steam cracker electrification aims to cut CO_2 emissions per cracker by 90 %. The chemical sector is an important contributor to restoring sustainable carbon cycles. Chemical products are a massive reservoir of carbon that can fix the carbon for 10-40 years. Today the volume of carbon embedded in chemical products is comparable to total emissions of the industry for the production of those. Even most of this carbon ends up in the atmosphere when products are incinerated at the end of their use, setting up an ambitious circular economy strategy is a pre-requisite for achieving sustainable and climate-resilient carbon cycles by keeping carbon 'in the loop'. The chemical sector can contribute to emission abatement in other sectors by 'absorbing' carbon and storing it in products.

4.8. Pulp and paper industry:

In the pulp and paper industry, a combination of process improvements, including the transition to Industry 4.0, along with investments in state-of-the-art production technologies, are expected to lead to a reduction of 7 million tonnes of CO_2 by 2050. Leveraging its on-site CHP facilities, the industry has the ability to engage on the energy market using surpluses of intermittent renewable energy. The associated decarbonisation benefits could be as high as 2 million tonnes. Further conversion of industrial installations to low- to no-carbon energy sources is projected to deliver an emissions reduction of 8 million tonnes of CO_2. In addition to some of the breakthrough concepts identified in the Two team Project ([4]), such as the Deep Eutectic Solvents technology now under development, other innovative and disruptive solutions could complement the emission reduction effort by some 5 million tonnes of CO_2.

4.9. Oil refineries:

Oil refineries have the potential to contribute to the energy and climate transition of the EU economy in two ways: i) by substantially reducing the carbon footprint of their manufacturing process, and ii) by progressively replacing fuels and other products of fossil origin with fuels and other products based on biogenic or recycled CO_2. The gradual replacement of fossil energy with bioenergy, coupled with CCU & CCS technologies, will even result in negative GHG emissions. The net GHG emissions generated during use of fuels and other refinery products can be radically cut by progressively switching the feedstock from crude oil to sustainable biomass and recycled CO_2. The resulting fuels, once burned, will add zero or very low net CO_2 to the atmosphere, thus contributing to the decarbonisation of transport, especially for those modes more difficult to electrify. Investments and new projects in these fields are ongoing. As an example, three of the approximately 80 major refineries in the EU have been converted to biorefineries, completely replacing crude oil with sustainable biomass ([5]). This climate transition strategy requires lower financial resources than other solutions, as the refineries themselves and the logistics system for the distribution of products can to a large extent be adapted and reused.

([4]) https://www.cepi.org/two-team-project-report/.
([5]) Gela, Venice biorefinery (eni.com) and La Mède (TotalEnergies.com).

4.10. Fertilisers:

The fertiliser industry is now exploring replacing natural gas as a raw material with green hydrogen. Several pilot projects ([6]) are being developed across the EU, and once green hydrogen becomes available and its cost is settled, the industry will move forward to full decarbonisation.

4.11. In conclusion, the manufacturing industry has potential for decarbonisation through energy efficiency, optimising processes and conversion to renewable energy. R&D&I investments will be needed in order to reach the carbon neutrality goal by 2050. CCS and CCUS technologies are also of importance for manufacturing industries such as the cement industry and where biomass is the energy source.

5. **Skills and competencies in the future manufacturing industry**

5.1. New industrial processes will undoubtedly demand new working methods. Industries and workers will need to adapt the way they perform their duties in the industry, focusing on reducing CO_2 emissions from the very first steps in the manufacturing processes.

5.2. The green transition of the manufacturing industry will change production in many ways, by fully deploying new production technologies and taking advantage of digitalisation. New skills and up- and reskilling, will be needed to achieve a just transition where no one is left behind. Special attention must be devoted to inviting EU citizens and workers, SMEs, social enterprises and regional experts to play a proactive part in the unavoidable change in the places where they live.

5.3. The EU must ensure that knowledge on new technologies and how to implement them in current industries reaches industry workers. Public authorities and companies, within the social dialogue, have to make the effort to leverage already existing skills as well to meet the decarbonisation objectives.

5.4. Full deployment of green hydrogen in the industry will be key for many industries. However, in addition, implementing the CDR technologies will influence skills and competencies in the manufacturing industry and also very much in the supply chain.

6. **EU action and framework conditions**

6.1. The EU legal framework and national regulations have to help decarbonise the industry. It should take into account that there are going to be different possibilities and/or resources to be invested for the transition that differ widely between Member States and between regions in Europe.

6.2. The Just Transition Fund dedicated to supporting regions that are highly dependent on carbon intensive industries is a positive first step. However, the scope, which is limited to regions highly dependent on coal, lignite, peat, oil shale and carbon intensive industries, is too narrow. The EESC, like the European Parliament, proposes dramatically increasing the Just Transition Fund budget, in order to provide support to other sectors that will be affected by the decarbonisation of industry. Additional budget resources should be earmarked to ensure job-to-job transition, alternative, quality job creation in the same regions and proper training, reskilling and upskilling of workers.

6.3. The green transition in industry will require access to abundant carbon neutral energy and feedstock at an affordable, stable and competitive price. Significant investments, including in energy infrastructure, will have to take place in Europe in order to meet industry's need for large quantities of renewable energy.

6.4. The EU regulatory framework must lead the EU economy to meet the objective of net climate neutrality in 2050 by creating the conditions to unlock the huge resources — financial, technological and intellectual — for investments in low-carbon technologies, including Carbon Removal Technologies, to be quickly implemented.

([6]) Fertiberia has launched Impact Zero fertilizer plant in Puertollano, Spain.

6.5. Regular incentives are needed to encourage the deployment of carbon capture in manufacturing industries, either at European level — through the Innovation Fund — and in every Member State, but without breaking up the Single Market, which is one of the cornerstones of the EU. Additional EU initiatives will be needed to attract and mobilise private investment.

6.6. Strategic alliances need to be forged at European level in order to speed up the development of this industry, enabling the EU to take the lead in this field. The current state aid rules could be adapted to allow this to happen.

6.7. Particular attention needs to be paid to R&D activities, with dialogue on this at European level. The Innovation Fund must be the preferred vehicle for channelling those activities.

6.8. Public procurement policies should be used to boost the markets for green products where producers are lowering GHG emissions vis-à-vis 'brown' products.

6.9. The identified delay in addressing the climate challenge and time pressure means that European Semester reporting and recommendations to every Member State must include some key performance indicators for helping to reach the needed industry decarbonisation.

6.10. The Strategic Foresight Report should review, periodically, the progress, the most promising scenarios/options and the weak points in attempts to achieve the climate goals. This is even more important as it can provide guidelines for urgent and high-risk investment, but also for reasonable resource-pooling, both vertically and horizontally.

6.11. A warning set of signals show a playing field that is not level and the risk of 'carbon-leakage' to third countries, hindering the no-carbon transition. This underlines once again the importance of introducing the competitiveness check as a risk-filtering and orientation tool.

6.12. There are clearly measured splits in emissions concentrations by Member States, emissions/capita, economic sectors and regions. Due to the time pressure, priority needs to be given to putting forward the quickest and biggest results bringing about decarbonisation steps. Therefore, there should be strong focus on metallurgies, mineral materials and chemicals and the renewable fuels industry.

Early-phase innovations and the desire to use and sell them differ according to the size of companies, with very large groups having an advantage with regard to the former, and SMEs with regard to the latter. Thus, both intersectoral and vertical knowledge transfer should be encouraged and facilitated by creating a favourable business environment.

Brussels, 21 September 2022.

The President
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