



# UNAVOIDABLE PRODUCTION OF CO<sub>2</sub> IN A CLIMATE-NEUTRAL PRIMARY SECTOR IN NORTH RHINE-WESTPHALIA – DEFINITION AND CRITERIA

A contribution towards the development of a carbon  
dioxide economy

Discussion paper by the working group on  
the carbon dioxide economy

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## UNAVOIDABLE PRODUCTION OF CO<sub>2</sub> IN A CLIMATE-NEUTRAL PRIMARY SECTOR IN NORTH RHINE-WESTPHALIA – DEFINITION AND CRITERIA

Even assuming that the German federal state of North Rhine-Westphalia (NRW) has achieved climate neutrality by 2050, it is probable that products will still be manufactured by means of industrial processes that produce carbon dioxide. That is why a solution must be found for managing the resulting volumes of CO<sub>2</sub>, and the appropriate technologies and infrastructure must be developed and implemented. The scale of current and future "unavoidable" CO<sub>2</sub> production has yet to be conclusively determined. However, it is already clear that "unavoidable" volumes of CO<sub>2</sub> will in any case continue to be generated in industrial processes in the future. There is, therefore, a need to clarify how this by-product can be managed with regard to the interplay between the sources of CO<sub>2</sub> and the options for utilising and storing it in North Rhine-Westphalia. In addition to overcoming technological and infrastructural barriers, it is widely understood that, above all, public acceptance of the approach to handling captured CO<sub>2</sub> is vital. With this in mind, clarifying the question of what volumes of CO<sub>2</sub> cannot be avoided in the process of realising a climate-neutral industrial sector in NRW is critically important.

The IN4climate.NRW initiative's working group on the carbon dioxide economy has taken on the task of drawing on scientific support to discuss the fundamental steps required to establish a carbon dioxide economy in North Rhine-Westphalia and documenting the findings of this discussion. As the general discussion over unavoidable volumes of CO<sub>2</sub> has not offered a clear definition of the term, this paper will present the working group's agreed definition of process-related CO<sub>2</sub> production, which clearly addresses the processes used in the primary sector. Furthermore, criteria will be identified that will play a role in the design of the potential processes and the resulting volumes of CO<sub>2</sub>. An examination that goes beyond process technologies alone also raises questions regarding the substitution of products with alternatives that either do not result in the production of any CO<sub>2</sub> or give rise to lower volumes. This discussion paper is therefore intended as an initial contribution to the dialogue on the future role of the carbon dioxide economy and the associated technologies and infrastructure needed in North Rhine-Westphalia in the context of the objective to establish a climate-neutral primary sector.

### Process-related CO<sub>2</sub> production – definition

"Process-related CO<sub>2</sub> production" refers to the formation of carbon dioxide in industrial processes that neither exclusively nor overwhelmingly serve to convert fossil primary energy carriers into energy for the generation of electricity or heat. One example of "process-related CO<sub>2</sub> production" occurs in the lime industry when carbon dioxide is given off by the carbonate rock during the burning process. "Process-related CO<sub>2</sub> production" relates to both the carbon dioxide that is released directly into the atmosphere and the carbon dioxide that is captured and processed further or stored (carbon capture and utilisation (CCU) / carbon capture and storage (CCS)).

### Bibliographic information

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## Identification of unavoidably produced CO<sub>2</sub>

CO<sub>2</sub> arising in relation to processes is deemed unavoidable to the extent that its production cannot be avoided despite optimisation of the production process or the product. This CO<sub>2</sub> is then classed as unavoidable in the context of the transformation into a climate-neutral primary sector when alternative processes and alternative products or resources for the same application are either not available or of limited potential.

The availability of alternative options will change over time and is driven by ongoing research and development with the result that CO<sub>2</sub> generation that is unavoidable today may be avoidable in the future when circumstances have evolved.

In order to evaluate processes with regard to the inability of avoiding CO<sub>2</sub> production in the future, we need to understand the volumes of process-related CO<sub>2</sub> arising today, the conceivable alternatives and their time frames.

A long-term examination calls for an assessment of the volumes of process-related CO<sub>2</sub> being produced today that are also likely to be present in NRW's climate-neutral industrial sector in 2050. The following factors must be taken into consideration (not exhaustive):

### Production

- Do production processes exist that yield an essentially comparable product while generating lower volumes of CO<sub>2</sub> or no CO<sub>2</sub> at all (e.g. switching to hydrogen-based steel production or making optimal use of additional main constituents in cement production given the decreasing availability of fly ash and ground-granulated blast-furnace slag, and using cement clinker as efficiently as possible in construction products)?
- Do production processes exist that give rise to other suitable product qualities while generating lower volumes of CO<sub>2</sub> or no CO<sub>2</sub> at all?
- Can any potential be found in implementing measures related to the circular economy and thereby reducing raw material inputs?
- Is there an opportunity for natural carbon sequestration / reabsorption of CO<sub>2</sub> through the process of carbonation in the utilisation phase / during the life cycle of the manufactured products (e.g. the formation of slag in steel production, hardening processes in the case of cement / mortar / plaster, flue gas cleaning)?

This gives rise to further questions such as:

- What additional changes in process control, product application or infrastructural links will this require in North Rhine-Westphalia and, where applicable, in neighbouring federal states and countries?
- Are these processes structurally (in terms of resources) and economically feasible in North Rhine-Westphalia?

### Demand

- Substitution
  - Can other suitable products be used for the same purposes without generating any process-related CO<sub>2</sub>? Which other greenhouse gas emissions and costs (economic and environmental) would result from the use of a substitute?
  - Can individual product components be replaced by alternatives whose value chains produce no CO<sub>2</sub> or lower volumes of CO<sub>2</sub>?
- Efficiency and reduction of product inputs
  - What contribution can be made by sufficiency / a sharing economy?
  - What contribution can be made by smart planning processes and product design (e.g. reducing the use of concrete thanks to intelligent component geometry)?
- Incentive instruments
  - What instruments can be implemented to create the demand and willingness to pay for products that, while being more efficient in terms of greenhouse gas emissions, are also more expensive? And when can these be put into effect?

## Supporting the emergence of a carbon dioxide economy – next steps

This discussion paper offers a definition of unavoidable volumes of CO<sub>2</sub>. Factors that influence the volume of CO<sub>2</sub> produced have been identified on the production side and on the demand side. These findings provide a basis on which to estimate how much CO<sub>2</sub> is being and will be unavoidably produced in which locations in North Rhine-Westphalia in a transformation pathway towards climate neutrality as well as which methods of managing the CO<sub>2</sub> are conceivable (utilisation, transport, storage). Once this aspect has been considered by the working group on the carbon dioxide economy, the emerging infrastructural challenges for North Rhine-Westphalia will be discussed. This paper thereby creates a basis for further discussions that will drive the formation of a carbon dioxide economy forward, supporting the transformation process towards the emergence of a climate-neutral industrial sector.



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