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Contextualization of Carbon Management in the current Climate Debate

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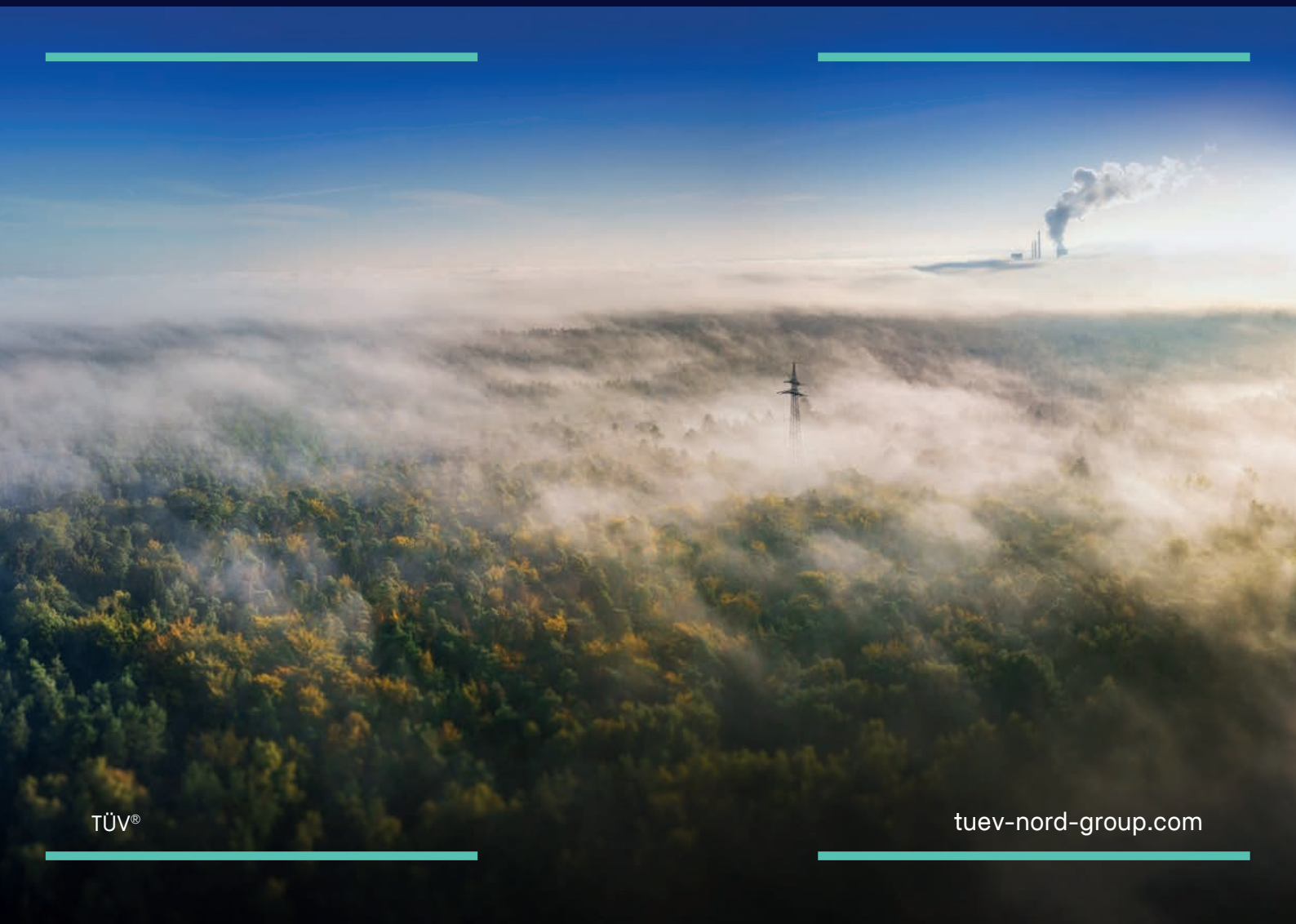

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Carbon Management

Carbon management encompasses the entire cycle of capturing, transporting, further utilizing (CCU – Carbon Capture and Utilization), and permanently storing carbon dioxide (CCS – Carbon Capture and Storage). It is intended to play a crucial role in global efforts towards decarbonization and mitigating negative impacts on the climate. Decarbonization refers to the transition of economic activities, particularly in the energy sector and energy-intensive industries, towards significantly lower CO2 emissions. The long-term goal is to create a carbon-neutral economy to reduce emissions that exacerbate the greenhouse effect and contribute to global warming. Ideally, the remaining unavoidable portion of emissions will be sustainably circulated within a closed loop or placed in permanent storage. The avoidance of new carbon dioxide emissions should be given prioritized attention in all carbon management efforts.

Carbon management encompasses a range of strategies and measures aimed at quantifying, reducing, or compensating for CO_2 emissions. These include improving energy efficiency, utilizing renewable energy sources, implementing carbon-free technologies, promoting sustainable land use and forestry, and developing carbon sinks such as reforestation, wetland restoration, carbon sequestration, or CO_2 storage in deep geological formations. TÜV NORD GROUP supports measures that serve the avoidance and reduction of carbon dioxide emissions. Prioritized avoidance strategies include transitioning swiftly to renewable energies. Permanent carbon dioxide storage can only be a solution for unavoidable CO_2 emissions and should only be used under strict safety requirements.

The avoidance of carbon dioxide emissions should be prioritized.

We consider carbon management an essential component in addressing climate change, which must encompass not only technological solutions but also political, economic, and social aspects. The key points for a Carbon Management Strategy (CMS), adopted by the Federal Cabinet in May, and the draft amendment to the German Carbon Dioxide Storage Act (KSpG), now consider CO_2 storage. This marks an important step towards achieving our climate goals. It is clear that merely avoiding additional CO_2 emissions cannot stop climate change, although it should be prioritized. Significant amounts of atmospheric carbon dioxide must also be captured and permanently stored. This diverges from the desired closed-loop CO_2 cycle—comprising capture, transport, "recycling," and reintegration into industrial applications—and introduces permanent CO_2 storage as a potential reduction method.

There are several global examples where Carbon Capture and Storage (CCS) is already operational, such as in reservoirs beneath the North Sea off Norway's coast. Over 30 projects (as of late 2023) are currently under development in Europe, but 100 out of 149 CCS projects planned by 2020 were canceled or indefinitely postponed.

Significant movement in the field of CCS will occur locally when the costs of CO_2 emissions (so-called CO_2 taxes) exceed the costs of CCS measures. With the current CO_2 price in Germany around €45 per ton and CCS costs ranging between €70 and €250 per ton of CO_2[1], there is no incentive for the industry to act accordingly. Only through gradually increasing CO_2 taxes and further politically driven measures (e.g., carbon contracts for difference or financial incentives) can CCS projects become economically viable. Some groundwork has already been laid in Europe: Denmark plans a CO_2 tax of €100 per ton, the Netherlands €125 per ton, and Norway even €195 per ton by 2030.

We believe that swift incentives must also be created in Germany to develop economic solutions that offer clear advantages of permanent storage over emission rights like CO_2 certificates. This should be accelerated by establishing clear legal

[1] Prices vary widely depending on location and infrastructure, including capture and transport costs, as well as final storage expenses.

frameworks, reducing bureaucracy, market-oriented simplification of regulations, and financial incentives through support programs. Simultaneously, it is essential to minimize the risks of CCS technology through careful site exploration and rigorous approval processes based on current scientific and technical standards. There are concerns in the debate about permanent CO_2 storage that promoting and expanding CCS technologies could prolong the use of fossil energy unnecessarily. It is essential to establish political and economically incentivized measures that advance decarbonization while simultaneously expanding the capture and storage of existing and unavoidable carbon dioxide.

Technically, there is a general risk of leakage in CCS processes. However, due to precise requirements for site selection, elaborate sealing, and meticulous monitoring during operation, the risk is manageable, and dealing with potential leaks is well planned. Strict safety standards must be adhered to in CCS projects to minimize leakage risks. Ongoing research and accumulated experience will help further improve this technology.

But let us categorize Carbon Dioxide from a material standpoint: CO_2, a colorless, odorless gas, occurs naturally but is also a product of industrial and energy processes, especially from the combustion of carbon-containing (organic) materials such as coal, natural gas, oil, and their products (various fuels, power plant coal, coke, plastics, etc.). On one hand, it is a climate-damaging gas, while on the other hand, as a carbon carrier, it has numerous applications across various industries. Unlike CO (carbon monoxide), which is considered toxic, CO_2 is generally seen as a more manageable medium. It is non-flammable and non-toxic at normal atmospheric concentrations (0.0407% in the air we breathe). In the unlikely event of a leak in underground CCS storage, the above-ground release concentrations would likely not be life-threatening. The expected CO_2 concentration at the leak site depends on various factors, including the size and location of the leak, the permeability of the surrounding rock, the pressure conditions in the storage site, the geochemical reactions in the rock, and the CO_2 flow rate. The properties of the chosen storage sites and the CCS-specific safety precautions, such as appropriate sensors, will minimize risks and should enable safe CCS technology.

Unavoidable CO_2 production (such as in the cement or chemical industries) under increasing and stricter climate targets means that companies must engage with innovative solutions

and avoidance technologies. If avoidance is not possible, CO_2 should be utilized in other processes or stored permanently. This means companies should consider various parallel approaches to CO_2 reduction and utilization, from Carbon Capture and Storage to using CO_2 for product manufacturing. We believe companies should communicate their CO_2 strategies openly, coordinate with stakeholders, and collaborate across industries to find sustainable solutions together.

Although CO_2 is generally considered safe, certain safety measures must be observed based on legal and technical requirements. These extend to the handling, transport, and storage of CO_2. In Germany, the Carbon Dioxide Storage Act (KSpG) provides this framework, outlining technical instructions and regulations, monitoring and safety regulations, and environmental impact assessments. CO_2 transport also requires special precautions, involving high-quality pressure vessels, secure pipelines, and strict safety protocols. Companies transporting CO_2 must adhere to procedures and standards to ensure safety. ISO 27913 defines CO_2 transport, taking material properties into account. For transport companies, standardized procedures for emission calculation according to EN 16258 exist. Finally, sustainable technologies and continuous employee training are crucial for comprehensive CCS management. Since CCS is not yet commercially widespread and carries certain risks, CCS projects should be closely monitored by experts. This is a core competency of TÜV NORD GROUP companies, which can provide comprehensive advice and support for implementing measures such as transport and storage.

TÜV NORD GROUP supports a holistic view of the carbon cycle and already collaborates with various stakeholders from business and politics in planning and implementing projects. Operationally independent areas of TÜV NORD GROUP are involved in supporting companies with the multifaceted challenges along the entire value chain. This includes, for example, the preparation or validation of strategies and feasibility studies, consulting, planning and implementation in plant construction, or regulatory and route engineering for networks and storage facilities. TÜV NORD GROUP's „Energy & Resources" business unit also invests in the development and advancement of various products and services to meet new market demands. These include, for example, the IoT platform Safeguard with comprehensive sensor technology for condition monitoring, as well as plant and site monitoring, investments in developing exploration technologies for CCS storage, and more. Simultaneously, other companies within TÜV NORD GROUP offer comprehensive services and products in traditional testing and certification, including carbon management.

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Conclusion

Avoidance strategies and the swift transition to renewable energies should be prioritized. Within the framework of carbon management, in conjunction with reducing existing CO_2 concentrations in the atmosphere through CCU measures and expanding permanent CO_2 storage (CCS), we can slow down or even halt climate change. CO_2, as a manageable medium, offers numerous opportunities for companies to expand their services and develop innovative solutions. The economic opportunities and the politically and environmentally driven necessity to utilize sustainable technologies make expertise in CO_2 management a forward-thinking focus for companies across various industries.

Carbon management can be seen as a potent opportunity for innovation and growth, acting as a driver for new business in plant and infrastructure construction, as well as a climate protection measure contributing significantly to the security, stability, and prosperity of our planet. Therefore, it must become a key issue for companies committed to their own sustainability goals and legislative requirements, aiming to set the stage for the future. With the right knowledge and appropriate measures, we can not only manage CO_2 but also leverage it to our advantage.

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