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Recent Advances in Carbon Capture and Storage Technologies and Their Potential for Emission Reduction

As global climate change intensifies, reducing greenhouse gas emissions has become a critical goal for governments and industries worldwide. Carbon capture and storage (CCS) technology has emerged as an effective means to achieve this goal. By capturing carbon dioxide (CO₂) produced during industrial and energy processes and securely storing it underground, CCS can significantly reduce the concentration of greenhouse gases in the atmosphere. Recent advancements in CCS technology, research, commercialization, and policy support offer new solutions for tackling climate change.

Advances in new materials and processes have continuously improved the efficiency and cost-effectiveness of carbon capture technologies. Researchers are developing novel adsorbents and solvents that enhance CO₂ capture efficiency while reducing energy consumption. Furthermore, progress in membrane separation technologies has opened new possibilities for efficient carbon capture. Numerous CCS demonstration projects have been launched globally, such as Norway's "Longship" project and Canada's "Boundary Dam Carbon Capture and Storage Project." These initiatives not only provide practical foundations for the commercialization of CCS technology but also accumulate valuable data and experiences that facilitate further development. In addition, governments worldwide are implementing policies to support CCS research and application. For instance, the United States offers tax incentives for CCS projects through the Inflation Reduction Act, encouraging companies to invest in carbon capture and storage facilities, creating a conducive environment for technology promotion.

CCS technology holds significant application potential in high-emission industries such as cement, steel, and chemicals. By implementing CCS, the industrial sector can substantially lower CO₂ emissions, aiding in the achievement of global reduction targets. Moreover, CCS can be integrated with renewable energy sources to promote low-carbon energy transitions. For example, the combination of biomass energy and CCS (BECCS) can achieve negative emissions by capturing more CO₂ during energy production, thus lowering atmospheric greenhouse gas concentrations. Additionally, in the process of capturing and storing carbon dioxide, CCS can be combined with other energy technologies to improve overall energy utilization efficiency, contributing to a

lower carbon footprint and supporting sustainable development.

In conclusion, carbon capture and storage technology demonstrates tremendous potential in addressing climate change and reducing emissions. With continuous technological advancements and policy support, CCS is expected to play an even greater role in the future. However, to fully realize its potential, further research, cost reduction, and global collaboration are necessary. Only through collective efforts can we effectively tackle the challenges of climate change and achieve sustainable development goals.