Carbon Direct

Large-scale carbon dioxide removal and dual accounting: Microsoft and Ørsted



Executive summary

In May 2023, Danish energy company Ørsted announced its first bioenergy with carbon capture and storage (BECCS) carbon dioxide removal offtake agreement.[1] This contract will see Microsoft purchase a total of 2.67 million tonnes from Ørsted's Kalundborg project over an 11-year period. The Danish government is also partly subsidizing this first-of-a-kind (FOAK) project in an effort to promote carbon capture and storage (CCS) as a key contributor to the fulfillment of Danish climate targets. Carbon Direct, which served as a technical advisor to the Microsoft deal, supports the implementation and deployment of advanced carbon removal technology as embodied by this project.

This contract has spurred important conversations[2] questioning how the purchase will simultaneously count toward Microsoft's carbon negative ambitions and toward the Danish national emissions inventory.[3] Carbon Direct maintains that the high-quality carbon removals resulting from this deal—like most greenhouse gas emissions—should be tracked via dual (parallel) accounting. In this framework, emissions and removals count once toward the emissions inventory of the private entity that purchases removals under the Greenhouse Gas Protocol. They are also counted once toward the national inventory of the country in which the carbon capture occurred. In other words, national emissions inventories reflect the sum of all emissions and removals that occur within national boundaries. No two private entities and no two national inventories claim the same climate attribute. This stands in contrast to the problematic phenomenon of double counting in which multiple private entities simultaneously claim credit for a single emissions reduction or removal—a practice which many, including Carbon Direct, work actively to curb.

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[1] *Ørsted. 2023. Ørsted awarded contract—will capture and store 430,000 tonnes of biogenic CO2.*

[2] *Romm J. 2023. Are carbon offsets unscalable, unjust, and unfixable—and a threat to the Paris Climate Agreement?*

[3] *Hoglund R. 2023. When do sales of carbon removal credits benefit climate?*

Cover image: Ørsted's Kalundborg combined heat and power plant. © Ørsted

KEY TAKEAWAYS

- → Ørsted's Kalundborg project is a first-of-a-kind BECCS plant that will serve as a testing ground and catalyst for further deployment of CDR technologies.
- → Combined private- and public-sector financial support, from Microsoft and the Danish Energy Agency, is crucial to the project's financial feasibility.
- → Both CCS and CDR technologies are significant parts of Denmark's ambitious climate goals.
- → This project tracks emissions removals in two parallel ledgers, representing dual tracking of a single carbon credit. This is currently the best practice for emissions accounting and is distinct from double-counting, which must be avoided. Double-counting occurs when a single carbon credit is applied to two private entity inventories simultaneously.

Project background

The multinational Danish energy company Ørsted operates a biomass-fired combined heat and power (CHP) facility as a utility, serving an industrial production complex and a district heating system in the town of Kalundborg, Denmark. In May 2023, Ørsted announced an award from the Danish Energy Agency (DEA) for a 20-year contract in support of its bioenergy with carbon capture and storage (BECCS) project, Ørsted Kalundborg CO_2 Hub.[1] This project will add amine-based carbon capture and sequestration (CCS) to the existing bioenergy plant. Captured CO_2 will be shipped to existing permanent geologic storage under the North Sea. The project will include the Kalundborg plant as well as another straw-fed BECCS plant in Copenhagen. Together, they will capture and store an estimated 430,000 tonnes of biogenic CO_2 per year.[2,3] Along with support from the DEA for the project, US technology company Microsoft has agreed to purchase 2.67 million tonnes of durable carbon dioxide removal from the plant in Kalundborg over 11 years.[4] This commitment represented, at the time, the world's largest carbon removal offtake agreement by volume.[5]

The energy feedstock[6] for the Ørsted BECCS facility is sustainable biomass, primarily wood chips that are residues from sustainably managed forests.[7] These materials would otherwise be burned or allowed to decompose, both processes which emit CO_2 into the atmosphere. By using them in a BECCS application instead, this biogenic carbon will be stored geologically for millennia and permanently kept from re-entering the atmosphere. As shown in figure 1, BECCS applications allow for additional carbon storage and avoided emissions as compared to alternative biomass fates such as open burning, decomposition, or use in a biomass-fed CHP plant without CCS.

[1] *Danish Energy Agency. 2023. The first tender of the CCUS subsidy scheme has been finalized: the Danish Energy Agency awards the contract to Ørsted's full scale CCS project.*

[2] *The EU has approved this scheme under state aid rules.*

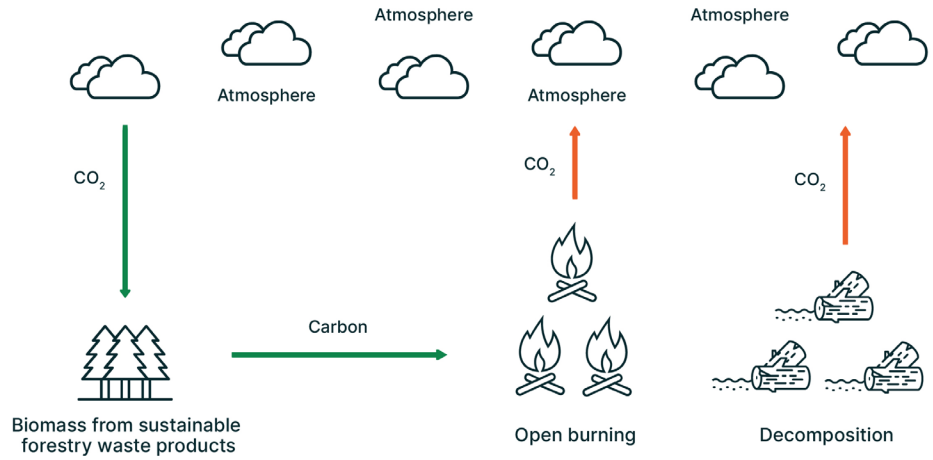
[3] *European Commission. 2023. State aid: Commission approves €1.1 billion Danish scheme to support roll-out of carbon capture and storage technologies.*

[4] *Ørsted. 2023. Ørsted awarded contract—will capture and store 430,000 tonnes of biogenic CO2.*

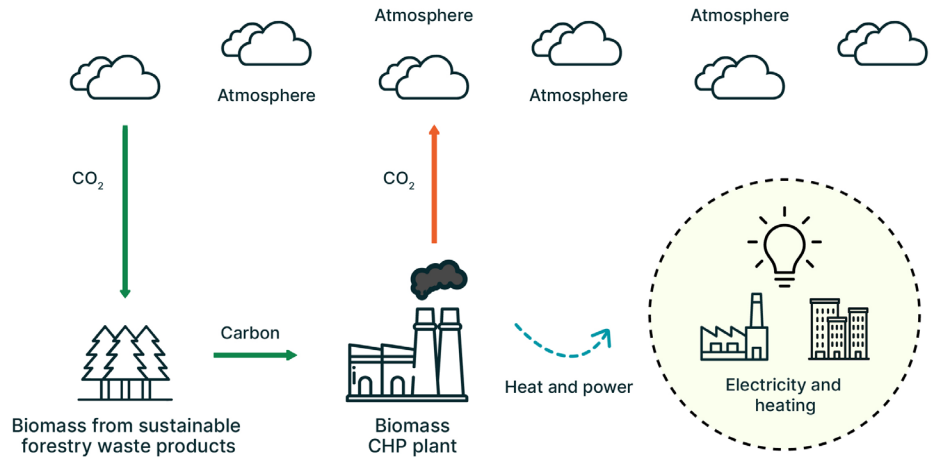
[5] *CDR.fyi. 2023. CDR.fyi 2023 Mid-Year Progress Report.*

[6] *Ørsted. 2023. 2023. Bioenergy: Burning organic matter instead of coal for Danish heating and backup power.*

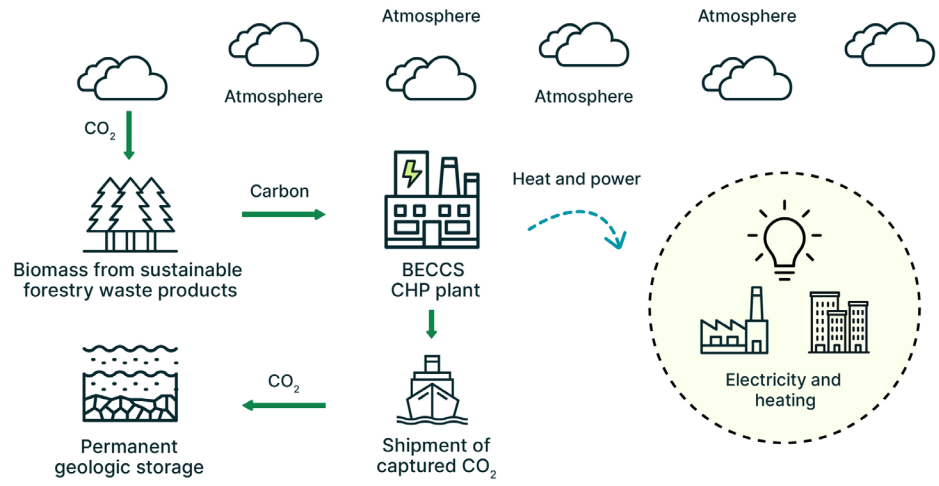
[7] *Ørsted. 2023. Our heat and power plants.*



Biogenic CO_2 from sustainable forestry waste products



Biogenic CO_2 from biomass-fed CHP plant



Additional carbon removal with BECCS CHP Plant

Figure 1. Diagram showing CO_2 flows and additional carbon removal via a BECCS CHP plant (bottom panel) as compared to alternative fates of biomass where biogenic CO_2 is returned to the atmosphere, such as in a biomass CHP plant without carbon capture and storage (middle panel), or when waste products from sustainable forestry are burned in the open or left to decompose (top panel).

Denmark has set a target to reduce their national greenhouse gas (GHG) emissions 70% by 2030, and plans for 10% of residual emissions to be removed through large-scale deployment of CCS technologies. To meet this goal, these CCS technologies will need to remove CO_2 at a rate of 3.2 million tonnes per year in addition to other reductions. For future tenders, in 2024–2025, Denmark plans to dedicate nearly US$4 billion over 15 years toward CCS projects that will capture 2.3 million tonnes of CO_2 per year.[8] Carbon removal is also an essential part of Denmark's future goals to achieve net-zero emissions by 2045, and a 110% reduction in emissions by 2050.[9] As Ole Thomsen, Senior Vice President and Head of Ørsted's Bioenergy business states:

> *"According to the UN's Intergovernmental Panel on Climate Change (IPCC), capture and storage of biogenic CO_2 is one of the tools we must use to fight climate change, and our CCS project will contribute significantly to realising the politically decided Danish climate targets for 2025 and 2030."* [10]

Nascent and necessary technologies—such as large-scale carbon dioxide removal (CDR) via projects like Ørsted's BECCS plant—benefit from coordinated investment efforts between the public and private sectors. First-of-a-kind (FOAK) projects such as this provide proof of concept, allow a testing ground for further innovation, and encourage dialogue on best practices around future deployment—including issues surrounding reporting and crediting for carbon removals. Large, multinational corporations with strong climate commitments like Microsoft have recognized and supported this need. As Nana Bule, then General Manager of Microsoft Denmark and Iceland[11] said:

> *"Partnership[s] across sectors and digital innovation are key in the fight against climate change. The plan to achieve the Danish ambition of 70% carbon reduction by 2030 relies in part on carbon capture and storage at scale, and we're excited to support this alongside Ørsted and Aker Carbon Capture."* [12]

[8] *Reuters. 2023. Denmark plans to allocate 28.6 bln crowns for new CO2 capture and storage tenders.*

[9] *Danish Energy Agency. 2023. Kilmastatus og-fremskrivning.*

[10] *Ørsted. 2023. Ørsted awarded contract—will capture and store 430,000 tonnes of biogenic CO2.*

[11] *Nana Bule is currently Board Member at Novo Nordisk Foundation, Energinet, and Arla Foods; Operating Advisor to Goldman Sachs Asset Management Value Accelerator; and Chair at Carbfix, the Denmark National Digital Council, and the Denmark Ministry of Climate, Energy, and Utilities, National Energy Crisis Staff Taskforce on Renewable Energy.*

[12] *Ørsted. 2023. Ørsted, Aker Carbon Capture, and Microsoft commit to explore development of carbon capture*

Additionality requirements are key. High-quality CO2 removals of all kinds must meet strict criteria for additionality.[13] Carbon Direct tracks the financial and regulatory additionality of any CDR project, asking two questions:

- Is carbon financing, through advanced purchase of CO2 credits or long-term contracting, required for the project to be financially feasible?
- Is the project not required by existing laws, regulations, or other binding obligations?

To be fully additional, the answer to both questions must be "yes." This is clearly the case for the Kalundborg Ørsted project. Without construction and operation of CCS infrastructure, CO2 emitted from the existing bioenergy CHP plant would return to the atmosphere. Microsoft's long-term contract to pay for the removals is necessary to support the economic feasibility of the project.

Although the Danish government is providing incentives to the Ørsted project, these were not sufficient to cover full project costs. Denmark's tender for CCS was designed to allow voluntary carbon finance without underpricing resulting credits on the voluntary carbon market or over-rewarding the bidder.[14] Microsoft is a pioneering buyer for these removals, but it is not shouldering the entire cost of FOAK innovation. Given the nascent state of bioenergy-based CCS, Danish state subsidies and Microsoft's contract were both necessary to make this project financially viable. Similar dynamics will play out in US-based carbon removals supported by the 45Q tax credits, and those projects will benefit from accounting and policy lessons learned from this Danish example.

This project is also not required under any law or regulation. The biogenic emissions that will be captured are exempt from the European Union (EU) carbon market, regulated by the Emissions Trading System (ETS). Although removals created by this project are intended to count toward Denmark's share of Europe's Nationally Determined Contribution (NDC) to the Paris Agreement, an NDC is an ambition and not an enforceable or mandatory regulation. There are potential questions around how to view additionality of climate benefits in light of country-level Paris target commitments. These questions are not unique to the Ørsted credits. They apply to nearly any emissions reduction or CDR credit claimed under both corporate climate goals and a country's NDC.

[13] *Carbon Direct and Microsoft. 2023. Criteria for High-Quality Carbon Dioxide Removal.*

[14] *Danish Energy Agency. 2023. Appendix 6: Subsidy and Economy Scheme.*

Dual accounting vs. double-counting

Dual accounting describes the practice of accounting for all GHG emissions in two ways—once in the inventory of the entity (corporation, individual, or public agency) responsible for the emission, and (in parallel) once in the national inventory of the country where the emission took place. It can be useful to think of dual corporate and national carbon inventories as analogous with corporate earnings and national gross domestic product (GDP).[15] Corporate activities within a country's borders contribute to and are reflected in a nation's GDP in the same way that corporate carbon mitigation activities within a country's borders contribute to and are reflected in the national carbon inventory. These activities are tracked in parallel inventories at the national level as well as at the smaller organizational level, but are not counted twice.

Dual accounting enables institutions to take responsibility for actions that affect their GHG emissions and allows countries to take responsibility for policies that affect the emissions-related behavior of individuals and institutions within their borders. Ideally, emissions are counted once and mirrored in two separate ledgers at both the entity level and at the national level. This is illustrated in table 1, where each row represents a country-level inventory, and each column represents a company-level inventory in millions of tonnes (Mt) of CO2. While each country and company will have its own totals, the end total for all countries matches the total for all companies—in this example, 430 Mt of CO2.

Table 1. Idealized Example of Dual Accounting

	Company 1	Company 2	Company 3	Country Totals
Country 1	20 Mt CO_2		50 Mt CO_2	70 Mt CO_2
Country 2		70 Mt CO_2	90 Mt CO_2	160 Mt CO_2
Country 3	100 Mt CO_2	80 Mt CO_2	20 Mt CO_2	200 Mt CO_2
Company Totals	120 Mt CO_2	150 Mt CO_2	160 Mt CO_2	**430 Mt CO_2**

However, both corporate and national GHG accounting systems have gaps, flaws, incompatibilities, and implementation challenges that cause significant deviation from the dual accounting ideal. Specifically, in the case of credits for emissions reduction or removal, these gaps create the potential risk of double counting. **Double counting** occurs when an institution counts a reduction toward its own emissions inventory and simultaneously sells that reduction to another party who applies it as a reduction to their own emissions accounting. Because the credit is applied to two private entity

[15] *Microsoft. 2023. Microsoft Carbon Removal: Observations from Our Third Year.*

inventories simultaneously, this kind of replication creates a false and overestimated account of climate action.[16]

Rules and protocols designed to prevent double counting exist, yet they are not entirely effective. The problem of double counting is exacerbated by international trade in emissions credits, which can spill over causing ineffective tracking of credits between institutional and national emissions inventories. The registries of the voluntary carbon markets are currently separated from national GHG inventories. As they become more formally connected, corresponding adjustments may be applied in cases where a company buys removals in a country where it has no (or limited) emissions to offset. These issues are not yet resolved under Article 6 of the Paris Agreement. While a fairly mature system for emissions tracking exists, there is not yet a system in place for the reporting and use of CDR credits in the EU. The EU is progressing on a legislated Carbon Removal Certification Framework (EU CRCF)[17] which will result in issuance of certificates of compliance and their registration. The rules governing how to retire and apply these certificates against emissions within a sector still need to be defined.

In the case of the Ørsted BECCS project, at the broadest level of analysis, it is subject to both national environmental policy (Denmark and the EU's regulations and incentives) as well as international climate obligations (embodied in the Paris Agreement). In terms of tracking project-related carbon accounting across Danish government, Microsoft, and other partner records; some guidance is proposed by The Nordic Dialogue on Voluntary Compensation.[18]

Comparable developments in Sweden also provide a model. The Swedish power company Stockholm Exergi recently made a proposal for a dual accounting structure that is:

> *". . .based on issuance of 'connected certificates' that would link 1) [carbon removal credit] certificates generated by capture companies and 2) standardized mitigation outcomes (SMO) in the resident country of capture."*[19]

This model allows non-state actors to compensate for their GHG emissions through the purchase of CDR credits supported, in part, by state subsidies. In the context of the Ørsted contract with Microsoft—and as it relates to the Danish national carbon inventory—the science team at Carbon

[16] *In the 2023 publication by Climate Focus, The Voluntary Carbon Market Explained, dual accounting is defined as "double claiming" and is contrasted to other more problematic forms of accounting such as double counting. See Chapter 4: "How are greenhouse gas reductions and removals accounted for in the voluntary carbon market?"*

[17] *European Commission. 2023. Carbon Removal Certification.*

[18] *The Nordic Dialogue on Voluntary Compensation. 2023. About. [accessed 2023 Oct 23]. https://nordicdialogue.com/about/.*

[19] *European Commission. 2022. Feedback from Stockholm Exergi.*

Direct is confident that current best practices for high-integrity carbon accounting and project quality are being followed. Carbon accounting practices are still evolving to provide more rigor and global integration across compliance and voluntary markets. Ambitious actors must seek out the best practices available at any given moment and adhere to them while simultaneously pushing forward high-quality climate action and innovation. The Ørsted-Denmark-Microsoft collaboration exemplifies this spirit of climate commitment and learning-while-doing.

Ørsted–Microsoft collaboration as a catalyst

Early corporate buyers of CDR credits play a pioneering role in defining how they are applied to company- and national-level decarbonization efforts. Carbon Direct advises its clients to work collaboratively and transparently with stakeholders on all sides of a deal, including the project developer, offtaker, and any subsidizing agencies. This is particularly true for path-finding projects where there is limited precedent for assigning carbon removal accountability. Buyers and sellers of carbon credits have an important role to play in modeling best practices during innovative transactions and in subsequent contracts. While formal guidance from governments and regulators on management of emissions accounting frameworks coalesces, actors in the CDR innovation space can help shape standards.

Microsoft submitted the following statement to the EU CRCF seeking guidance on carbon removal accounting as it relates to Internationally Transferred Mitigation Outcomes (ITMOs):

> *"With 2030 fast approaching and many other corporate actors seeking to get more involved in the removal space, we seek clear and universal rules for a) corporate and national accountings of carbon removal and b) (relatedly) when CDR tonnage can and/or needs to be converted to ITMOs. Harmonization of definitions between Article 6 of the Paris Agreement and the EU CRCF would facilitate a greater influx of private capital for funding mitigation measures (both avoidance and removal) within the EU by both corporate and private entities."*

Full transparency in carbon accounting, clarity and certainty around dual-accounting practices, and full auditability to prevent double-counting will stimulate further investment in much-needed CDR projects while discouraging investment in fraudulent projects. This is the current and very necessary work of countries, companies, experts, and members of civil society engaged in accelerating climate solutions.[20] Improvements will be made through diligent co-operation, clear-

[20] *Luers A, et al. 2022. Make greenhouse-gas accounting reliable—build interoperable systems. Nature. 607(7920):653–656. doi:https://doi.org/10.1038/d41586-022-02033-y.*

eyed technical assessments, and pushing forward with FOAK projects that will lead the way to scaled, effective climate solutions with measurable impacts. These efforts must be translated into explanations that stakeholders, including lay people with a keen interest in positive climate outcomes, can easily grasp and understand. While there is much work ahead, stepping-stone projects such as Ørsted serve as a catalyst for future success while exemplifying the public-private partnership and ambition our era calls for.

This sentiment is echoed in Microsoft's 2023 publication, Microsoft Carbon Removal: Observations from Our Third Year, which states:

> *"As the global community seeks to mitigate the worst effects of climate change, including by fulfilling the goals of the Paris Agreement…We see many situations where both public and private funds are necessary to make new projects economically viable; were it not for both public subsidies and corporate offtake agreements, many projects expected to generate high-quality carbon removal would not get built."*[21]

Combined, government and corporate funding streams are able to amplify the effect of their capital, bring new capacity to market, and advance the technical "on-the-ground" learning needed to fully optimize commercial-scale deployments to come.

Conclusion

Large-scale CDR deployment via projects like Ørsted's Kalundborg BECCS plant benefit from coordinated investment efforts between the public and private sectors. Pioneering projects such as this will promote the maturation of emerging commercial, economic, technical, and policy frameworks governing carbon removals. Scientists and analysts at Carbon Direct are actively engaged in corporate, national, and international discussions that will define these frameworks. Ørsted, Microsoft,and the Danish government are commended for moving forward with a project that is technologically ready. Governance issues concerning international contributions to climate change mitigation, related to Article 6 of the Paris Agreement, are currently under development and negotiation, as are issues surrounding the EU CRCF. Deployment of projects like Ørsted's will inform ongoing discussions, encourage firmer frameworks, and catalyze further high-quality CDR scale-up. These projects are a crucial piece of the effort to limit global warming to 1.5°C by 2050, as underscored in reports from the IPCC. They play an important role in meeting national climate goals, can store biogenic carbon for millennia, and provide a needed source of climate-friendly energy to industry and municipalities.

[21] *Microsoft. 2023. Microsoft Carbon Removal: Observations from Our Third Year.*

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About Carbon Direct

Carbon Direct helps organizations go from climate goal to climate action. We combine technology with deep expertise in climate science, policy, and carbon markets to deliver carbon emission footprints, actionable reduction strategies, and high-quality carbon dioxide removal. With Carbon Direct, clients can set and equitably deliver on their climate commitments, streamline compliance, and manage risk through transparency and scientific credibility.

Our expertise is trusted by global climate leaders including Microsoft, American Express, and Alaska Airlines, as well as by the World Economic Forum, which selected Carbon Direct as an Implementation Partner for the First Movers Coalition. To learn more, visit www.carbon-direct.com.

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