Working Paper
SWP Working Papers are online publications within the purview of the respective Research Division. Unlike SWP Research Papers and SWP Comments they are not reviewed by the Institute.

SWP

RESEARCH DIVISION EU / EUROPE | WP NR. 03, NOVEMBER 2022

Fit for purpose? Assessing the potential of current governance approaches to Carbon Dioxide Removal in China, the United States and the European Union.

Chloé Ludden

1. Modern Man in search of a solution.

The last seven years have been the seven warmest on record (Copernicus Climate Change Service (C3S) 2022). In fact, the last decade was warmer than any multi-century period after the *Last Interglacial*, roughly 125,000 years ago. Global surface temperature has increased by an average of 1.09°C between 1850–1900 and 2011–2020 (IPCC 2021). Hence, from 2020 onwards, the remaining carbon budget aligned with 1.5°C is merely of 500 gigatonnes (Gt) CO_2[1] (IPCC 2021), against annual global emissions of approximately 39.3 GtCO_2 in 2021 (Friedlingstein et al. 2022). Despite such unambiguous background, pledges for 2030 submitted by parties to the UNFCCC, or Nationally Determined Contributions (NDCs), remain insufficient to reach emissions levels consistent with the Paris Agreement's long-term temperature goal (IPCC 2022). In addition, CO_2 emissions in 2021 have already returned to pre-COVID emissions levels. Thus, in combination with insufficient national mitigation targets, global emissions trends actualise rather than avoid the occurrence of a temperature overshoot[2] pathway.

[1] Estimated with a 50% probability. A carbon budget of 1150 Gt CO_2 is estimated for a probability of 67% to limiting warming to 2°C. Remaining carbon budgets depend on the amount of non- CO_2 mitigation (±220 Gt CO_2) and are subject to geophysical uncertainties.
[2] Temperature overshoot, as defined in the IPCC Glossary, refers to the temporary exceedance of a specified level of global warming, such as 1.5°C. Overshoot implies a peak followed by a decline in global warming, achieved through anthropogenic removal of CO_2 exceeding remaining CO_2 emissions globally.

Overshoot pathways imply greater climate-related, social, and environmental risks, and are subject to feasibility concerns[3] (IPCC 2022). Yet, it is more likely than not that under a very low greenhouse gas (GHG) emissions scenario, global surface temperature relative to 1850-1900 would decline back to below 1.5°C toward the end of the 21st century, with a temporary overshoot of no more than 0.1°C above 1.5°C global warming (IPCC 2021). Hence, temporarily exceeding the 1.5°C threshold appears unavoidable, even under the most stringent decarbonisation scenario. Realistic climate policy therefore implies anticipating mitigation and adaptation efforts today, to limit the duration, width, and impacts of a foreseeable temperature overshoot.

Keeping long-term temperature increase at a maximum of 1.5°C relies on drastic mitigation efforts in the short term, and the establishment of net zero or net-negative emissions systems at the global, national, sectoral or supply chain level. Net zero GHG or CO_2 emissions systems can be achieved through Carbon Dioxide Removal (CDR) techniques, which remove CO_2 from the atmosphere to store it durably in geological, terrestrial, or ocean reservoirs, or in products. A plethora of CDR methods exist, and have been practised for centuries to millennia, such as afforestation and improved forest management, wetland restoration, and soil carbon sequestration – although not with the intention to deliberately remove carbon on a large-scale. Other methods such as Direct Air Carbon Capture and Storage (DACCS), Bioenergy with Carbon Capture and Storage (BECCS) and Enhanced Weathering are relatively new. Their knowledge base and scales of deployment are more limited (IPCC 2022), (Babiker et al., 2022). While CDR captures CO_2 from the atmosphere, carbon capture and storage (CCS) captures CO_2 from emissions sources, such as coal-fired power plants or cement factories, to sequester carbon underground. Carbon capture and storage based on fossil fuels and industrial processes is referred to as FFI-CCS in this working paper.

In the scenarios assessed by the IPCC, CDR is no substitute for deep emissions reductions but rather complements ambitious global and national mitigation strategies. First, by further reducing net GHG or CO_2 emissions levels in the short term. Second, by counterbalancing hard-to-abate residual emissions from sectors such as industry, transport and agriculture to address mid-term emissions. Finally, if deployed at levels exceeding annual residual gross CO_2 or GHG emissions, CDR can achieve and sustain net-negative CO_2 or GHG emissions in the long term (IPCC 2022).

Carbon dioxide removal has gained political momentum since the adoption of the Paris Agreement (UNFCCC 2015)[4], the publication of the IPCC's Special Report on Global Warming of 1.5°C (IPCC 2018), and the rapid diffusion of net zero emissions target announcements (Schenuit et al. 2021). Most U.N member states have announced GHG neutrality targets, which include non-CO_2 gases and CO_2, although the exact scope of a minority of targets remains unclear or undecided. In combination with deep reductions in both CO_2 and other GHG emissions, CDR is inherent to the achievement of these net-zero emissions targets, chiefly to compensate for residual emissions[5] in hard-to-transition sectors such as transport and heavy industry (IEA 2022). The timing and scale of CDR deployment will de-

[3] The duration of the overshoot has direct implications for food production and the regional distribution of mitigation costs. See Drouet et al. 2021.

[4] Article 4.1 of the Paris Agreement explicitly stipulates the need "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century […]" (UNFCCC, 2015).

[5] Total amounts of residual emissions depend on technological feasibility, economic opportunities, and political choices on the determination of sector-level contributions.

pend on sectoral gross emissions reductions, national reduction trajectories, and the development of effective approaches to address feasibility and sustainability constraints, especially at large scales of deployment (IPPC 2022). International collaboration, policy learning, and knowledge and technology transfer are therefore essential to global CDR deployment. However, although balancing residual emissions through CDR is emerging as a new organising principle of climate policy (Schenuit et al. 2021), the profusion of net-zero targets announcements since 2020 has not led to the clear quantification and distribution of responsibilities regarding CDR. Moving from intention signalling to implementation, countries are now expected to specify the scope of their targets, articulate how these targets are deemed adequate and fair, and communicate concrete roadmaps towards and beyond net zero (Rogelj et al. 2021). We contribute to this discussion by conducting a cross-country comparison of the role of CDR in the achievement of climate mitigation ambitions in China, the United States, and the European Union. These jurisdictions have been selected for their prominent role in international climate policy, the availability of information, and their high share of current and historical global emissions. Governance structures, path dependencies, existing CDR targets, policies or announcements are compared based on desk research to provide a snapshot of the different levels of CDR integration across all three jurisdictions.

2. The People's Republic of China, on the road to an Ecological Civilisation delivered by ordinance

The Chinese economy is currently the largest contributor to global carbon emissions, responsible for 32% of the world's territorial-based CO_2 emissions in 2020 (Statista 2022). That same year, during the 75th session of the United Nations General Assembly, President Xi Jinping announced China's dual objective: to peak CO_2 emissions by 2030 and reach carbon neutrality by 2060. The country also renewed its 2030 NDC, which aims to reduce carbon emissions per unit of GDP by over 65% compared to 2005 levels. China has already reduced the carbon intensity level of its GDP by 40–45% in 2020 compared to 2005. This target was primarily achieved through the introduction of top-down administrative measures, namely, the attribution of national goals to local and regional governments (Liu et al. 2022).

China's carbon neutrality objective is enshrined in the wider development of an "ecological civilization" (*shentai wenming*), as specified at the Ninth Meeting of the Central Committee of Finance and Economics chaired by Xi Jinping on March 15, 2021. The country has now entered its 14th Five-Year Plan (FYP) (2021-2025), with one of the steepest roads to net zero CO_2 emissions in the world ahead. As introduced above, just as numerous ways to reduce anthropogenic emissions exist, there are different methods and means to remove CO_2 from the atmosphere. The Chinese government appears to be betting on afforestation and reforestation, which would need to be deployed at an unprecedented scale in order to compensate for residual national CO_2 emissions. Provinces in southwest (Yunnan, Guizhou and Guangxi) and northeast China (Heilongjiang and Jilin provinces) especially, have established a pattern of rapidly expanding regional afforestation. Forest areas have increased by between 0.04 million and 0.44 million hectares per year over the past 10 to 15 years (Liu et al. 2022). These changes are driven by the plantation of fast-growing forests for timber export and domestic paper production, which do not provide for long term carbon dioxide removals. In addition, CDR gains from afforestation are limited to the duration of the trees' growth cycles, and permanence is not guaranteed, since forests are increasingly exposed to pests, natural hazards and extreme weather events.

Credits generated through afforestation may be traded under the pilot national ETS (Shrestha et al. 2022). However, afforestation and reforestation projects in China are implemented on unfertile, remote mountainous lands, and associated with greater costs compared to industrial forest plantations (Zhou et al. 2017). Moreover, landowners lack active participation and consultation rights in the design of carbon forestry projects and retribution schemes. Forest agencies, local governments and private enterprises have invested in carbon projects established on forest land owned by collectives of rural households. These landowners have in most cases not participated in the planning and design of carbon forest projects (Zhou et al. 2017). As a result, frequent conflicts between landowners and project developers are reported. In practice, landowners favour fast-growing species to reap the short-term economic benefits associated with timber production, while project developers alone benefit from carbon credits[6]. A configuration which hinders the viability of large-scale carbon sequestration projects in China. The potential of ocean-based CDR methods was also considered in a 2021 report by the Chinese Academy of Sciences (Jiao 2021), although no clear policy development is identifiable to date.

For the Chinese economy to reach carbon neutrality in the given timeframe, non-fossil fuel sources are estimated to account for 85% of the energy mix by 2050 (He et al. 2022). When fossil energy currently accounts for nearly 85% of China's total energy (Zhang et al. 2021). Evidence in support of FFI-CCS can be found in the Chinese literature related to the transformation of the energy sector available in the English language (Singh et al. 2019). All eight commercial FFI-CCS facilities currently in operation capture CO_2 emissions from fossil fuel combustion, such as coal-fired power plants, or fossil/mineral process emissions, such as from petrochemical processes (Liu et al. 2022). Although FFI-CCS effectively reduces emissions to a lower or even near-zero level, carbon dioxide removal is only possible through bioenergy combustion with CCS (BECCS), or through other methods that capture CO_2 emissions from ambient air or biogenic rather than fossil sources (Fuss et al. 2014). CDR from BECCS can be expected to play a significant role in the cost-effective decarbonisation of the Chinese energy sector (Weng et al. 2021), (Huang et al. 2020), (Xing et al. 2021). Indeed, BECCS provides additional time, and more affordable means, to energy-consuming sectors to transition at lower mitigation costs. One study argues that widespread development of, as well as inevitable reliance on BECCS and biofuels beyond 2030, are key characteristics of China's contribution toward the long-term temperature goal of the Paris Agreement (Pan et al. 2018). Another study published by the Chinese Academy for Environmental Planning (CAEP), a research institute close to the government, estimates that removals to be achieved by BECCS and Direct Air Carbon Capture and Storage (DACCS) need to reduce national carbon dioxide emissions by 0.3-0.6 billion tons and 0.2-0.3 billion tons respectively in 2060 (Cai et al. 2021). Ultimately, the country's emissions reduction pace, energy choices, scale of gross residual emissions from fossil fuels use and industry, combined with the introduction of other removal strategies, will define BECCS' exact role and deployment trajectory.

Mitigation efforts in China are essentially the outcome of a coincidental alignment of interests between local actors' realities and policies dictated by the central government (Engels 2018). Bottom-up efforts to promote a just transition, set voluntary local mitigation targets, perfect the carbon trading scheme and mobilise society are not prevalent in the Chinese People's Republic, although called upon by academics (Zhang et al. 2021). Regions and provinces will play a major role in the country's transition to net zero CO_2 emissions, with

[6] Between 63% (Zhou et al. 2017) and 80% (Fang and Gao 2015) of landowners surveyed in Guangdong related to carbon forestry activities were found unaware of the project.

national targets traditionally relying on regional-level mitigation. As an illustration, thousands of power plants and factories were shut down by central and local governments to achieve the carbon intensity reduction target established in the 12th FYP (2011–2015). Provincial targets at administrative levels were also set to achieve 18% reduction in carbon intensity of GDP during the 13th FYP (2016-2020) (Xie 2021). Accordingly, Chinese provinces may formulate specific implementation plans, local emissions reduction targets and removal targets. This target delegation may further derive to the city level, since each province can allocate reduction targets to cities on its territory so that, by extension, national targets can be achieved. Such a governance scheme, while promising in theory, can prove detrimental to a smooth and deep transition when combined with poor coordination and harsh pressure to deliver, as illustrated by the "dual-control" mechanism introduced during the five-year plan for 2016-2020. The policy required provinces to place a cap on local energy use and cut GDP intensity. Several provinces were unable to achieve their allocated targets, resulting in authorities enforcing last-minute power cuts in December in order to uphold year-long performance targets (Xie 2021). Delivering removals through CDR relies on very different governance schemes than delivering emissions cuts arbitrarily, by temporarily shutting down installations. Relying on local authorities to achieve national net zero CO_2 targets appears difficult in this context.

In China, carbon peaking and carbon neutrality are two stages of the same goal on the path towards the national interpretation of an "ecological civilisation", which relies on CDR to counterbalance remaining emissions. The country's pathway to net zero emissions will be instrumental to remain within the long-term temperature target outlined in the Paris Agreement. Afforestation programs and the inclusion of forestry projects in the ETS indicate that CDR-relevant governance is already present in the country. However, the absence of policies and incentives specifically for CCS-based CDR methods such as BECCS and DACCS, can prove detrimental to China's effective decarbonisation given the high amount of residual emissions to be expected on the way to 2060.

3. De-facto CDR governance in the United States of America

Since 2018, the United States has been the world's largest producer of oil and natural gas (U.S. Energy Information Administration 2022). The country re-entered the Paris Agreement under the auspices of the Biden administration and submitted an enhanced NDC to the UNFCCC in April 2021. President Biden also announced a net-zero GHG emissions target by 2050, in the run up of COP26, which relies on a ''whole-of-government' approach where ministries, federal agencies and the private sector are identified as key actors. The US government aims to reduce national emissions through procurement power and investments in clean energy infrastructure and manufacturing, with the clear intention to derive economic competitiveness, job creation, as well as industrial and innovation leadership.

The US Department of State and the US Executive Office of the President published the *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050* in November 2021. The strategy acknowledges that some sources of non- CO_2 emissions, and potentially some CO_2emissions, may not be reduced to zero by mid-century and must therefore be balanced-out by CO_2 removals. All twelve scenarios considered in the strategy document involve carbon dioxide removal activities at low, medium or high deployment levels. Transport, building, and industry-related emissions fall dramatically across all scenarios with electrification, transportation and non-land sink CDR responsible for the bulk of net emissions reductions. Although CDR is considered critical to reach net-zero by 2050 and achieve net negative emissions thereafter, dedicated policy instruments, economic incentives and governance structures remain unspecified. The US strategy simply notes that "*CDR technologies will only deliver desired societal and environmental benefits if their deployment is well-designed and well-governed*" (US National Net Zero Strategy).

Since 2010, observers note the gradual structuring of an ecosystem involving academic actors, small and large companies and representatives of civil society multiplying initiatives to transform the energy transition into economic opportunities, including in the field of carbon dioxide removal (Bekki et al., 2021). In October 2018, the National Academy of Sciences, Engineering, and Medicine (NASEM) released a detailed research agenda on carbon removal needs in the United States, along with funding level recommendations. As follow-through, in 2019, the charity-funded Energy Futures Initiative (EFI) released the *Clearing the Air: A Federal RD&D Initiative and Management Plan for Carbon Dioxide Removal Technologies* report to add substance to the NASEM recommendations with implementation plans. American foundations, often linked to the largest fortunes, have also unveiled funding programmes dedicated to CDR projects such as the Apple and Conservation International Restore Fund ($200 million), the Nature Conservancy project ($100 million), the World Wildlife project ($100 million) and the Environmental Defense project ($100 million) from the Bezos Earth Fund. The $100 million XPRIZE for Carbon Removal offered by the Musk Foundation and the undisclosed amount of funds initially provided by the Gates Foundation to Carbon Engineering, a Canadian company leading the development of Direct Air Capture (DAC), are other examples of this trend. Venture capital is actually characteristic of the American innovation system. CDR is no different, with government funding lagging behind the mobilisation of private investments. For instance, the US Department of Energy (DOE) launched a project to support direct air capture (DAC) in the form of a $12 million prize competition in 2021, when DAC projects received a total of $280 million from private venture capital between 2015 and 2020 (Bekki et al., 2021). In 2022, the Frontier Fund, a privately owned corporation supported by Stripe, Alphabet, Shopify, Meta, and McKinsey, was also launched to provide an additional $925 million to CDR start-ups. The US government is now inverting this trend, with the provision of $3.5 billion to fund four regional direct air capture hubs under the Infrastructure Investment and Jobs Act, also known as the BIL[7].

In coherence with its leadership position in oil and gas production, the US is a world leader in Carbon Capture and Storage technologies due to its colossal oil industry and massive R&D investments[8]. The US holds a competitive edge on geological storage, but the policy focus is placed on capturing and storing emissions from fossil fuels – coal, oil and gas – which, as exposed above, do not provide for carbon dioxide removal. The US envisaged pathway has received strong criticism and pushback from civil society actors. In August 2021, 500 organisations sent an open letter to President Biden and Canadian Prime Minister Trudeau to call for a FFI-CCS ban, particularly when used for enhanced oil recovery[9]. While FFI-CCS, DACCS and BECCS share common technological building blocks, they serve very different means. The US government is increasingly differentiating processes that reduce CO_2 emissions from those which remove CO_2 from the atmosphere, primarily through the creation of dedicated R&D and regulatory frameworks.

[7] $700 million annually for the five years period 2022-2026, Public Law 117-58.

[8] Already in 1997, the US Department of Energy launched a RD&D programme dedicated to the various building blocks of the CCUS sector, for a total investment of $4 billion between fiscal year 2012 and 2018. Congressional Research Service, July 2018.

[9] EOR is a process whereby CO_2 is injected into depleted underground oil reservoirs to boost oil production.

CDR is allocated a new funding line, for the first time separated from FFI-CCS for emissions from fossil fuels and industrial processes programmes, in the budget of the US Department of Energy (DOE) for the fiscal year 2022. A total of $64 million in budget request is dedicated to the research, deployment and demonstration of CDR projects in direct air capture (DAC), carbon capture and storage (CCS) coupled with the conversion of biomass waste to energy (BECCS), enhanced weathering through carbon mineralisation, soil sequestration techniques (e.g. improved forest management, reforestation and afforestation) and carbon capture by coastal or wetland ecosystems (Department of Energy 2021). The second main funding actor is the US Department of Agriculture (USDA), which dedicated $4 billion in FY 2022, $647 million more than the 2021 enacted level- to agricultural research, education and innovation projects in science and data-based application tools "*to put US technologies in the hands of farmers*" (FY 2022 Budget Justification 2021). The creation of a multi-agency initiative through a $161 million request also aims to foster the development of new indicators and tools to measure, monitor and verify carbon storage on federal lands.

On the regulatory side, President Biden has promulgated two executive orders in January 2021 to establish new task forces, workgroups, and advisory committees on climate change science and policy. Different federal states can be expected to progress at a different pace on CDR. This governance structure may contribute to the fruitful diversification of CDR activities across the country, providing effective joint initiatives and policy learning. Some states are already acting as pioneers, with the Californian Congress amending the California Climate Crisis Act to legally clarify the notions of carbon capture at source and direct capture from the atmosphere, and distinguish between "CO_2 intensity reduction" and "CO_2 removal" techniques in July 2021. Other states have also enacted CDR-related regulations since 2020 and introduced measures. Although numerous bills have entered the legislative process under the 116th and current 117th Congress, those which have passed the US Congress to date are not directly related to CDR. The CHIPS and Science Act, for instance, was passed in August 2022 and aims to "*help ensure America's place as a global leader in science and technology*"[10]. The bill establishes a *Carbon Sequestration Research* initiative, a *Centre for Greenhouse Gas Measurements*, *Standards, and Information*, and provides an additional $1 billion over four years to the DOE to carry out R&D and demonstration projects[11]. Also passed in August 2022, the Inflation Reduction Act extends the 45Q tax credit for carbon sequestration from $50 to $85 per metric ton, thereby easing the financial viability of projects that capture carbon dioxide from industrial facilities with lower CO_2 concentrations. The eligibility threshold is reduced from 100 thousand tonnes per year to 1000 tonnes, so that pilot and small scale facilities become eligible. Tax credits allocated to DAC projects also increase to $180 per ton. Finally, the bill dedicates $300 million to quantify, assess, monitor and track carbon sequestration, methane, and nitrous oxide emissions through the Greenhouse Gas Inventory and Assessment Program of the Department of Agriculture. An additional $50 million incentive aims to allow states and other eligible entities to provide payments for carbon sequestration to private forest land owners[12] .

Although technological building blocks are known, deployment remains unresolved and uncertain due to lasting questions on the financing of transport infrastructure, technological

[10] Press statement by Antony J. Blinken, Secretary of State. August 9, 2022

[11] Text - H.R.4346 - 117th Congress (2021-2022): Supreme Court Security Funding Act of 2022 | Congress.gov | Library of Congress

[12] Text - H.R.5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022 | Congress.gov | Library of Congress

uptake, social acceptance and the consideration of other ecosystem services. American civil society and companies can be expected to play a major role in the establishment of de-facto CDR governance. US start-ups are already taking the lead in the creation of voluntary carbon sequestration accounting instruments (e.g. Climate Action Reserve) and new business models based on voluntary carbon markets (e.g. Nori). Today, US farmers can generate carbon credits and directly connect with other service users such as citizens, farmers or companies willing to buy these credits. In the case of Nori, an audit is scheduled at the end of the 10 years storage period to compare stated objectives with actual achievements. One decade is an extremely short timeframe for effective CDR, and there is no guarantee that the farmer will not return to previous agricultural practices. The risk of simply destocking carbon later is high, which reveals the limits of analogous market-led approaches.

To conclude, CDR is a bi-partisan policy issue in the US and evolves in a nascent but rapidly evolving landscape. Prominent themes emphasised by NGOs in the country include the need for CDR in climate action, economic opportunities, and innovation (Schenuit et al. 2021). The US strategy acknowledges the need for meaningful and equitable community engagement for the successful implementation of CDR initiatives, and DAC projects funded through the BIL provisions will include "Equity, Environmental and Energy Justice (EEEJ) principles and priorities"[13] . However, how these priorities, principles and engagement processes are to unfold exactly remains unspecified. Dedicated markets are already taking shape, while regulations and state-led R&D are still under development. Although part and parcel of the US decarbonisation strategy, CDR is not associated with standard methods to certify and verify the quantities of carbon stored. Carbon creditors may design their own verification schemes and assessment methods. Hence, a dynamic, entrepreneurial-oriented ecosystem of private funds, researchers, businesses and NGOs is actively shaping the de-facto governance of carbon dioxide removal in the United States.

4. De-jure CDR governance in the European Union

On the other side of the Atlantic Ocean, the EU has prioritised the decarbonisation of its energy system. The European Green Deal, announced in late 2019, explicitly aims to decouple GHG emissions from economic growth, decrease resource consumption, but also address regional and social inequalities and achieve energy sovereignty. The 2021 European Climate Law[14], central piece of legislation, enshrines the EU economy-wide net zero greenhouse gas emissions target by 2050 into law. An arsenal of legislative proposals, the so-called "fit for 55 package", aims to ensure that short-term action is taken in parallel to achieve the interim NDC target of 55% reductions in net emissions by 2030[15] . A Union-wide net-zero GHG target allows Member States to contribute differently to the overall EU reduction target, according to national specificities and geographies[16] . In this communal context, timely progress in specific Member states or sectors can compensate for delayed emissions in other parts of Europe (Geden/Schenuit 2020). Based on this premise, early European movers might be expected to compensate for remaining emissions in hard-to-transition sectors.

[13] US Department of Energy Notice of Intent No.: DE-FOA-0002746. Available at https://www.energy.gov/bil/four-regional-clean-direct-air-capture-hubs
[14] Regulation (EU) 2021/1119
[15] Compared to 1990 levels.
[16] However, all member states are bound to individual national targets for renewable energy, energy efficiency and emissions reduction for the period 2021 – 2030, through the submission and update of National Energy and Climate Plans in negotiation with the Commission.

The EU Effort Sharing Regulation (ESR) applies to sectors not covered by the EU Emissions Trading System (ETS), such as transport, building, agriculture, and waste, which are precisely hard-to-transition sectors. The ESR therefore covers many sectors prone to important potential residual emissions, and could benefit from a replication toward the inclusion of CDR activities. Iceland, Norway and the EU Member States have set binding targets for greenhouse gas emissions reductions for 2030 under the ESR regulation. In line with this model, Member States could engage with all levels of government to design policies and measures that would contribute to the deployment of CDR at the regional level. The replication of the ESD model to set national CDR targets does not exclude the inclusion of CDR in the EU ETS (Schenuit et al. 2021). Instead, national CDR targets would provide investment signals to markets, clarify responsibilities, and ensure that the financial incentives necessary to drive emissions reductions and CO_2 removal simultaneously are available on the road to 2050. A CDR Effort Sharing Regulation would need to ensure the fungibility of CDR credits with other accounting units and policy instruments (e.g. Carbon contracts for difference, Carbon farming mechanisms) to connect sectors and countries where CO_2 removal potentials and CO_2 storage capacity do not match.

The current ESR regulation also provides for the inclusion of CDR through its interaction with the LULUCF regulation. The LULUCF regulation applies to EU member states and ensures that accounted emissions from Land Use, Land Use Change and Forestry (LULUCF) are fully compensated by accounted atmospheric CO_2 removals. This "no-debit rule" establishes that annual emissions allowances from the ESR need to be transferred to balance emissions in the LULUCF sector. Limited flexibility allows a maximum transfer of 280 Mt (i.e. 1% of annual ESD emissions from 2005) LULUCF credits to achieve the national reduction targets under the ESR. As a whole, the LULUCF sector is a net carbon sink in the EU, absorbing nearly 10% of total EU GHG each year[17]. Following a two-phase approach, the new LULUCF framework sets binding removal targets for each member state up to 2030. Member states ought to balance emissions and removals in the LULUCF sector up to 2025. From 2026 onwards, each member state's targets must contribute to the achievement of the new EU-wide target for net removal of -310 Million tonnes of CO_2 equivalent (Mt) in 2030.

The EU Commission also aims to align the European Common Agricultural Policy with its climate objectives, to support carbon farming projects, and achieve a balance between GHG emissions and removals in the land sector. Already in December 2020, the Commission recommended the inclusion of carbon sequestration activities in the Common Agricultural Policy (CAP) Strategic Plans prepared by Member States. A new CAP was adopted in December 2021 and is now due to be implemented from 1 January 2023. EU countries will implement the new CAP though a CAP strategic plan at national level. These National Strategic Plans ought to dedicate 25% of the anticipated budget to "eco-schemes", and attribute 35% to environmental, climate and animal welfare measures. The draft strategic plans are currently assessed by the Commission until the end of 2022. A preliminary summary overview for the 27 member states was published in June 2022. The report indicates that 21 Member States have set targets for carbon storage in soil and biomass, with half of them targeting more than 30% of the utilised agricultural area. Member States must also include agricultural knowledge and innovation systems in their plans, to ensure that knowledge transfer

[17] https://www.consilium.europa.eu/en/infographics/fit-for-55-lulucf-land-use-land-use-change-and-forestry/

and innovation can contribute to the locally relevant deployment of carbon farming strategies.

The EU Commission is aware of the difficulties associated with designing a robust monitoring, reporting and verification (MRV) framework for the certification of CDR methods. A regulatory proposal is expected by the end of 2022. In accordance with the Better Regulation Guidelines, a regulatory impact assessment (RIA) will then be carried out to assess and balance risks. Impact assessments have been used for nearly 20 years in the EU, both as a tool and a process, to inform policy making, improve or revise regulations, and manage their outcome (OECD 2022). Contrary to traditional “command and control” approaches to regulation, RIAs allow for the consideration of alternative policy designs, evidence-based policy choices, and the balancing of options through stakeholder participation. In parallel to its own reflection, the Commission will also create an expert group to develop standards for the certification of carbon removals. Expert groups bring authorities and stakeholders across member states together to share experiences, exchange best practises for carbon farming, and jointly assess the monitoring, reporting and verification of the certification process.

Finally, the Trans-European Networks for Energy (TEN-E) Regulation was revised in June 2022 to modernise Europe’s cross-border energy infrastructures and align with the Green Deal objectives. One of the three ‘priority thematic areas’, in addition to smart grids deployment and electricity highways, is the creation of a cross-border carbon dioxide network. Trans-border CO_2 transport and storage is now officially encouraged, and implemented through the launch of Projects of Common Interest (“PCI”) among EU member states. The regulation also includes third parties for the first time, under Projects of Mutual Interest (“PMI”). PCIs and PMIs hold priority status to ensure rapid administrative and judicial treatment, and are eligible for financial assistance. The first list of PCIs adopted under the new regulation can be expected in autumn 2023.

The above-mentioned governance and market structures, regulatory practices and public participation mechanisms will play a key role in facilitating the deployment of CDR across the EU. The “Sustainable Carbon Cycles” Communication published by the European Commission in December 2021 was the first attempt to clarify how the EU could promote and regulate regional CO_2 removal activities. After specifying an ambitious net-zero GHG emissions target, the EU Commission is now specifying the intermediate steps. EU institutions, but also some Member States such as Finland, Sweden and Germany, are increasingly engaging in policy discussions and forging new alliances in CDR research and development (e.g. German Coalition Agreement 2021). Yet, CDR is still not addressed in a comprehensive and strategic manner at the member state level. In fact, no MS holds a strategy dedicated to CDR (Meyer-Ohlendorf et al., 2022). The impetus provided by the EU Commission is essential, but uptake across MS will be fundamental to ensure large-scale CDR deployment in Europe. Still, long-lasting governance framework such as the the Responsible Research and Innovation (RRI) practice standard, the precautionary principle and the no harm rule stemming from environmental law, open public consultation mechanisms and transparent funding rules, place the region in a pioneering position to ensure the responsible and effective deployment of CDR options. Federal and citizen-led initiatives are paving the way forward, such as the European Open Science Cloud which aims to build an open federal cloud to provide a multi-disciplinary environment to European researchers, innovators, companies and citizens which would be particularly relevant for CDR research and development[18]. Citizen-

[18] European Open Science Cloud (EOSC) | European Commission (europa.eu)

led crowdfunding platforms, such as Time for The Planet are also providing funding to early stage[19] CDR projects.

5. Conclusions

The global potential of CDR is limited due to technical, social and sustainability factors (IPCC 2018, IPCC 2021, IPCC 2022) and important uncertainties remain[20]. Case studies and cross-country comparisons are particularly valuable in this context to provide an assessment of different national specificities, governance structures and path dependencies, contextualise mitigation targets, and provide opportunities for policy replication and learning. Carbon dioxide removal is certainly no substitute for emissions reduction, and has started to enter national debates in China, the U.S. and the European Union.

		Level of CDR integration			
		Overall climate ambition	*Role of CDR in climate targets*	*Governance structures and path-dependencies*	*Existing CDR policies and announcements*
Juridiction	*China*	Peak CO2 emissions by 2030 Achieve carbon neutrality by 2060	Unacknowledged and unspecified	No public participation. Uncoordinated mitigation action through decentralised target allocation	Carbon forestry projects included in the pilot ETS. FFI-CCS plants from fossil fuels and industrial sources
	United States	Net-zero GHG emissions target by 2050 50-52% reductions in GHG emissions in 2030 (2005 levels)	Acknowledged and unspecified	CCS to capture and store carbon from fossil fuels emissions. Proactive venture capital, private philanthropy and civil society	Investment in R&D and demonstration projects. Focus on regulatory and market based tools such as volontary carbon markets and the creation of standards
	European Union	Net zero GHG target by 2050 in law 55% reductions in net GHG emissions by 2030 (1990 levels)	Acknowledged at the EU Commission level and unspecified	Inter-pillar flexiblity between the ESR and LULUCF regulations. Responsible Research and Innovation (RRI). Precautionnary principle	Incentive to deploy CO2 transport and storage. Carbon MRV scheme. Revision of the CAP strategic plans

Compared to China, where innovation is planned by the central government and mitigation targets allocated to sub-administrative levels, innovation in the United States stems from market needs and actors, which are prone to play a decisive role in the choice and deployment of CDR methods. Innovation in the EU is overseen by standards, such as the Responsible Research and Innovation (RRI) conduct standard. European governance schemes also include participatory mechanisms, which can ensure democratic oversight over the choice of mitigation pathways. Importantly, environmental and social assessments ought to feed into policy decisions when assessing the role of CDR in national transition pathways, to avoid locking into inappropriate strategies. The EU has initiated the construction of a trans-border carbon network and the definition of MRV standards. However, the effective deployment and fair distribution of CDR activities in Europe remains to be delineated. The 'effort sharing' model already includes key European CDR actors such as Iceland, where the construction of the world's biggest direct air capture and storage plant has started in June, and Norway, which has launched the *Longship Project*, a €1.7 billion investment project aiming

[19] Time for the Planet (time-planet.com)
[20] Regarding land-use change, freshwater use, nutrients availability which raises concerns over food security and water shortage. See Smith et al., 2016; Minx et al., 2018

to develop an open access infrastructure for CO_2 transport and storage facilities under the North Sea. As such, the ESR would present a practical way forward in the definition of CDR potentials, targets, and policies.
Beyond the achievement of its own ambitions, European climate policy seeks to contribute to bringing global temperatures back down to the 1.5-degree threshold in the longer term (Dröge and Geden 2022), which depends on the availability of carbon dioxide removal on a global scale. In this context, the EU may act as a global laboratory, where countries with different starting points, energy mixes and CDR potentials engage on a joint net-zero trajectory on a much smaller scale. Science diplomacy initiatives dedicated to CDR, both between EU member states and with international partners, offer promising tools to foster the understanding of CDR techniques and their political uptake. Emerging economies and developing countries have already pointed to the Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC), enshrined in the UNFCCC, to call upon industrialised countries to lead on carbon dioxide removal. In a cross-regional joint statement including India, Bolivia, and China, India's Permanent Representative to the United Nations indicated that "developed countries must reach Net Zero well before 2050 in order to achieve overall global net zero target by around mid-century on the basis of equity, CBDR and RC, poverty eradication and sustainable development. We, therefore, call on developed countries to get Net-Negative in 2050, in order to vacate carbon space in 2050 for developing countries to grow till they too reach Net-Zero" (Permanent Mission of India to the UN, New York 2022).

The United States and Europe are responsible for the bulk of historical cumulative emissions so far. Fair-share calculation studies attribute two to three times larger CDR responsibilities to the triad this century (Fyson et al. 2020). In accordance with the enforcement of the CBDR-RC and the polluter pays principle, these jurisdictions are accountable, and responsible, for the bulk of carbon dioxide removal to provide time for the rest of the world to decarbonise. Importantly, emerging markets and developing economies now account for more than two-thirds of global CO_2 emissions, which raises fundamental questions of knowledge and technology transfers and patent rights, which ought to be considered upfront to also deploy CDR in developing economies in the long run.

In conclusion, only near-term action and more ambitious NDCs can minimise reliance on CDR in the long term (Strefler et al. 2018). Despite the central role of carbon dioxide removal to keep the 1.5°C target within reach, to bring down cumulative CO_2 emissions and to limit the duration of the overshoot, no party to the UNFCCC has clearly articulated how net negative emissions ought to be achieved at the national level, let alone distributed globally (Honegger und Reiner 2018), (Mohan et al. 2021). International cooperation should work towards ensuring that CO_2 removal and storage consider geographic, economic, institutional and social specificities, in conjunction with the global distribution of historical responsibility. Indeed, the costs and potential for achieving emissions reductions and removals are unevenly distributed geographically. Reaching net-zero CO_2 emissions globally will involve a combination of CDR options, across numerous sectors and jurisdictions.

UNFCCC parties established a mechanism to review progress towards the goals of the Paris Agreement, the so-called Global Stocktake (GST), and clarified its modalities during the Katowice Climate Change Conference in 2018 (COP24). The GST will be conducted for the first time in 2023 (COP28) and every five years thereafter. The first technical dialogue (TD), a conversation among Parties, experts and non-party stakeholders which lays the ground for the outputs of this review process, took place in Bonn in June 2022. CDR was included in the presentation of the key findings from the IPCC WG III report relevant for the GST. Both the TDs and GST will inform the preparation of the next round of Nationally Determined Contributions (NDCs) in 2024-25. The potential inclusion of CDR in the Chinese climate governance architecture remains unclear going forward due to the uncoordinated orchestration of actors responsible for climate action, decision scales, and distribution of effective decision power. The United States can be expected to upscale CDR, in parallel to FFI-CCS, to meet national decarbonisation targets. The European Union, through the impulsion of the EU Commission, has initiated the design of a robust regulatory framework. The EU's Carbon Removal Certification Mechanism, to be published in November, paves the way for further economic incentives and political uptake across member states. Beyond emissions cuts, the role of CDR, CCS and CCUS to reach net negative emissions in Europe is increasingly acknowledged. In this context, if the EU would establish a European-wide CDR target[21] , the Union would provide a significant message to the international community: that Europe is pulling its weight in the global transition.

[21] Built upon the removal targets newly established under the LULUCF revision for instance.

References

Liu, G., Cai, B., Li, Q., Zhang, X., & Ouyang, T. (2022). China's pathways of CO2 capture, utilization and storage under carbon neutrality vision 2060. Carbon Management, 13(1), 435-449. doi:10.1080/17583004.2022.2117648

Institute of Climate Change and Sustainable Development of Tsinghua University et al. (2022): China's Long-Term Low-Carbon Development Strategies and Pathways. Comprehensive Report. 1st ed. 2022. Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-2524-4

Congressional Research Service 2021. Carbon Capture and Sequestration (CCS) in the United States. Retrieved November 1, 2022, from https://sgp.fas.org/crs/

Copernicus Climate Change Service (C3S) (2022). European State of the Climate 2021 Summary. Copernicus Climate Change Service (C3S). https://doi.org/10.21957/9D7G-HN83

Department of Energy (2021): FY 2022 Congressional Budget Request. Budget in Brief. Office of Chief Financial Office Research Service 2021, Carbon Capture and Sequestration (CCS) in the United States. Retrieved November 1, 2022, from https://sgp.fas.org/crs/

Dröge, S., & Geden, O. (2022). Next COP ahead. Stiftung Wissenschaft Und Politik (SWP), German Institute for International and Security Affairs. https://doi.org/10.18449/2022C02

Drouet, Laurent; Bosetti, Valentina; Padoan, Simone A.; Aleluia Reis, Lara; Bertram, Christoph; Dalla Longa, Francesco et al. (2021): Net zero-emission pathways reduce the physical and economic risks of climate change. In: *Nat. Clim. Chang.* 11 (12), S. 1070–1076. DOI: 10.1038/s41558-021-01218-z.

Engels, Anita (2018): Understanding how China is championing climate change mitigation. In: *Palgrave Commun* 4 (1), S. 1–6. DOI: 10.1057/s41599-018-0150-4.

Friedlingstein, Pierre; Jones, Matthew W.; O'Sullivan, Michael; Andrew, Robbie M.; Bakker, Dorothee C. E.; Hauck, Judith et al. (2022): Global Carbon Budget 2021. In: *Earth Syst. Sci. Data* 14 (4), S. 1917–2005. DOI: 10.5194/essd-14-1917-2022.

Fuss, Sabine; Canadell, Josep G.; Peters, Glen P.; Tavoni, Massimo; Andrew, Robbie M.; Ciais, Philippe et al. (2014): Betting on negative emissions. In: *Nature Clim Change* 4 (10), S. 850–853. DOI: 10.1038/nclimate2392.

FY 2022 budget justification. Office of the Chief Financial Officer (2021). Retrieved November 1, 2022, from https://www.energy.gov/cfo/articles/fy-2022-budget-justification

Fyson, Claire L.; Baur, Susanne; Gidden, Matthew; Schleussner, Carl-Friedrich (2020): Fair-share carbon dioxide removal increases major emitter responsibility. In: *Nat. Clim. Chang.* 10 (9), S. 836–841. DOI: 10.1038/s41558-020-0857-2.

Geden, O., Schenuit, F., Stiftung Wissenschaft Und Politik (2020). Unconventional mitigation. Carbon Dioxide Removal as a New Approach in EU Climate Policy. SWP Research Paper. https://doi.org/10.18449/2020RP08

German Coalition Treaty (2021): Koalitionsvertrag 2021 – 2025 zwischen der Sozialdemokratischen Partei Deutschlands (SPD), BÜNDNIS 90 / DIE GRÜNEN und den Freien Demokra-ten (FDP). Retrieved November 1, 2022, from https://www.bundesregierung.de/resource/blob/974430/1990812/04221173eef9a6720059cc353d759a2b/2021-12-10-koav2021-data.pdf?download=1

IPCC, 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. In Press.

Honegger, Matthias; Reiner, David (2018): The political economy of negative emissions technologies: consequences for international policy design. In: *Climate Policy* 18 (3), S. 306–321. DOI: 10.1080/14693062.2017.1413322.

Huang, Xiaodan; Chang, Shiyan; Zheng, Dingqian; Zhang, Xiliang (2020): The role of BECCS in deep decarbonization of China's economy: A computable general equilibrium analysis. In: *Energy Economics* 92, S. 104968. DOI: 10.1016/j.eneco.2020.104968.

IEA (2020), Global Energy Review 2020, IEA, Paris https://www.iea.org/reports/global-energy-review-2020, License: CC BY 4.0

IPCC (2021): Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Unter Mitarbeit von Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Hg. v. IPCC. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32. doi:10.1017/9781009157896.001.

IPCC (2022): Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Unter Mitarbeit von P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi,A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.). Hg. v. IPCC. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

Jiao, Nianzhi (2021): Developing Ocean Negative Carbon Emission Technology to Support National Carbon Neutralization. DOI: 10.16418/j.issn.1000-3045.20210123001.

The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050. Published by the United States Department of State and the United States Executive Office of the President, Washington DC. November 2021. United Nations Framework Convention on Climate Change Retrieved November 1, 2022, from https://unfccc.int/sites/default/files/resource/US_accessibleLTS2021.pdf

Liu, Zhu; Deng, Zhu; He, Gang; Wang, Hailin; Zhang, Xian; Lin, Jiang et al. (2022): Challenges and opportunities for carbon neutrality in China. In: *Nat Rev Earth Environ* 3 (2), S. 141–155. DOI: 10.1038/s43017-021-00244-x.

Meyer-Ohlendorf, Nils, Deyana Spasova (2022): Carbon Dioxide Removals in EU Member States. Ecologic Institute, Berlin

Mohan, Aniruddh; Geden, Oliver; Fridahl, Mathias; Buck, Holly Jean; Peters, Glen P. (2021): UNFCCC must confront the political economy of net-negative emissions. In: *One Earth* 4 (10), S. 1348–1351. DOI: 10.1016/j.oneear.2021.10.001.

Pan, Xunzhang; Chen, Wenying; Wang, Lining; Lin, Lu; Li, Nan (2018): The role of biomass in China's long-term mitigation toward the Paris climate goals. In: *Environ. Res. Lett.* 13 (12), S. 124028. DOI: 10.1088/1748-9326/aaf06c.

Cross- Regional Joint Statement on Global Net Zero Delivered by Ambassador T.S. Tirumurti Permanent Representative of India to the United Nations on behalf of Bolivia, China, Gabon, India, Iran, Iraq, Mali, Nicaragua, Panama and Syria. (2022, June 7). Retrieved November 1, 2022, from https://pminewyork.gov.in/others?id=NDYzNA%2C%2C

Rickels, W., Proelß, A., Geden, O., Burhenne, J., & Fridahl, M. (2020, September 08). The future of (negative) emissions trading in the European Union. Retrieved November 1, 2022, from https://www.ifw-kiel.de/experts/ifw/wilfried-rickels/the-future-of-negative-emissions-trading-in-the-european-union-15070/

Rogelj, Joeri; Geden, Oliver; Cowie, Annette; Reisinger, Andy (2021): Net-zero emissions targets are vague: three ways to fix. In: *Nature* 591 (7850), S. 365–368. DOI: 10.1038/d41586-021-00662-3.

Schenuit, Felix; Colvin, Rebecca; Fridahl, Mathias; McMullin, Barry; Reisinger, Andy; Sanchez, Daniel L. et al. (2021): Carbon Dioxide Removal Policy in the Making: Assessing Developments in 9 OECD Cases. In: *Front. Clim.* 3, DOI: 10.3389/fclim.2021.638805.

Schenuit, F., & Geden, O. (2022). Carbon dioxide removal. Stiftung Wissenschaft Und Politik (SWP), German Institute for International and Security Affairs. https://doi.org/10.18449/2022WP02

Shrestha, Anil; Eshpeter, Sarah; Li, Nuyun; Li, Jinliang; Nile, John O.; Wang, Guangyu (2022): Inclusion of forestry offsets in emission trading schemes: insights from global experts. In: *J. For. Res.* 33 (1), S. 279–287. DOI: 10.1007/s11676-021-01329-5.

Singh, Surinder P.; Hao, Pingjiao; Liu, Xiao; Wei, Chang; Xu, Wayne Qiang; Wei, Ning et al. (2019): Large-Scale Affordable CO2 Capture Is Possible by 2030. In: *Joule* 3 (9), S. 2154–2164. DOI: 10.1016/j.joule.2019.08.014.

Office for Science & Technology of the embassy of France in the United States. (2021, October 29). Retrieved November 1, 2022, from https://france-science.com/rapport-dambassade-interventions-sur-le-climat-etat-des-lieux-des-initiatives-aux-etats-unis/

Published by Ian Tiseo, & 23, J. (2022, June 23). China: CO2 emissions 1960-2020. Retrieved November 1, 2022, from https://www.statista.com/statistics/239093/co2-emissions-in-china/

Strefler, Jessica; Bauer, Nico; Kriegler, Elmar; Popp, Alexander; Giannousakis, Anastasis; Edenhofer, Ottmar (2018): Between Scylla and Charybdis: Delayed mitigation narrows the passage between large-scale CDR and high costs. In: *Environ. Res. Lett.* 13 (4), S. 44015. DOI: 10.1088/1748-9326/aab2ba.

U.S. energy information administration (EIA). Retrieved November 1, 2022, from https://www.eia.gov/tools/faqs/faq.php?id=709&t=6

Paris Agreement - UNFCCC. (2015). Retrieved November 1, 2022, from https://unfccc.int/sites/default/files/english_paris_agreement.pdf

Weng, Yuwei; Cai, Wenjia; Wang, Can (2021): Evaluating the use of BECCS and afforestation under China's carbon-neutral target for 2060. In: *Applied Energy* 299, S. 117263. DOI: 10.1016/j.apenergy.2021.117263.

The local government failures behind China's power crisis. (2021, September 29). Retrieved November 1, 2022, from https://www.scmp.com/news/china/politics/article/3150631/local-government-failures-behind-chinas-power-crisis

ZHANG, Yongsheng; CHAO, Qingchen; CHEN, Ying; ZHANG, Jianyu; WANG, Mou; ZHANG, Ying; YU, Xiang (2021): China's Carbon Neutrality: Leading Global Climate Governance and Green Transformation. In: *Chn. J. Urb. Environ.Stud* 09 (03), Artikel 2150019. DOI: 10.1142/S2345748121500196.

Zhou, Wei; Gong, Peichen; Gao, Lan (2017): A Review of Carbon Forest Development in China. In: *Forests* 8 (8), S. 295. DOI: 10.3390/f8080295.

Chloé Ludden, Scientific Assistant. EU/Europe Division, German Institute for International and Security Affairs (SWP)

This Working Paper reflects the author’s views.

SWP
Stiftung Wissenschaft und Politik
German Institute for International and Security Affairs

Ludwigkirchplatz 3–4
10719 Berlin
Telephone +49 30 880 07-0
Fax +49 30 880 07-100
www.swp-berlin.org
swp@swp-berlin.org

doi: 10.18449/2022WP09