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DISCUSSION PAPER MAY 2020

EUROPEAN CCS: LEARNING FROM FAILURE OR FAILING TO LEARN?

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After a decade of false starts Carbon Capture and Storage (CCS) has returned to the EU climate policy agenda. The European Green Deal has put mid-century climate neutrality at the heart of the EU's future economic, climate and energy policy – and CCS could be a critical tool for tackling emissions in areas where there are few alternatives. The pathway to Europe becoming climate-neutral is yet to be determined, but any inclusion of CCS in future plans must be within the broader aim of decarbonisation and not be viewed as a policy end in itself. To ensure this, there must be a proper understanding of how and where CCS might be best deployed to help deliver climate neutrality. This paper identifies the minimum requirements for CCS to have any role in Europe's decarbonisation, building on experience from previous attempts to develop CCS.

Key points

- **Europe can lead the world on regulating the deployment of CCS for climate neutrality.** Although CCS has already been deployed in other regions, Europe is in a strong position to lead the next phase of CCS development. The policy, regulatory, and financial frameworks that support the clean transition mean Europe can develop CCS in a way that contributes to achieving mid-century climate neutrality.
- **The deployment of CCS must be targeted as there are limitations that affect its potential end use**. Although CCS may help abate emissions in some sectors, its technical and geographic limitations mean it is not an economy-wide solution for climate neutrality. Moreover, it should only be deployed as a decarbonisation tool of last resort, and not supersede other methods of moving to a climate neutral economy.
- **Developers need to build the public interest case for CCS**. Building the public interest case and gaining a 'social licence' means CCS developers need to engage stakeholders across social, environmental, and political organisations, as well as in local communities. As part of this, the role of incumbent oil and gas companies must also be regulated to make use of their technical skills relevant to CCS, but in way that does not undermine the broader transition to climate neutrality.

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> **CCS infrastructure development must be jointly planned and coordinated by the EU, its member states, and local bodies.** Although the development of CCS is potentially crucial for the EU's target of climate neutrality, not all member states will be able to develop it at scale. Sub-national authorities, national governments, and the EU must also cooperate across policy making and regulation.

CCS and mid-century climate neutrality[1]

The European Green Deal has highlighted the potentially crucial role CCS could play as an 'innovative infrastructure' in achieving the EU's target of net-zero greenhouse gas emissions by 2050.[2] This language builds on the inclusion of CCS in the 2018 long-term strategy for climate neutrality, where it was included in future scenarios for decarbonisation pathways, delivering reductions of between anywhere between 52 $MtCO_2$ and 606 $MtCO_2$. For comparison, the upper end of this range is equivalent to around a third of total EU ETS emissions in 2018.[3] While the inclusion of CCS in these policy frameworks is important, both the long-term strategy and the European Green Deal recognised that the potential role for CCS is more narrow than previously thought, with a much reduced role in the power generation sector and a focus instead on tackling industrial emissions from specific sub-sectors.[4]

Achieving deep decarbonisation in heavy industry sectors – notably steel, cement, and chemicals – is a challenge. These sectors have high levels of process emissions which in some cases cannot be fully abated, despite using mitigation methods such as electrification, energy efficiency or material efficiency.[5] Some sectors such as steel and ceramics also require the supply of a very high level of heat (currently from burning a fossil fuel) which cannot easily be replaced by electrification with current technologies.

CCS could also play a role in the production of hydrogen, which could be a lower carbon feedstock for industry or play a role in domestic heating and backup power generation. Hydrogen produces no carbon when it is combusted, but there are carbon emissions in its production if made using natural gas, as well as fugitive methane emissions in the

[1] Although there may be opportunities to develop CO_2 Utilisation (the U sometimes included to form the initialism CCUS – carbon capture usage and storage) in specific localities, it is likely to have limited scale and will not be an option for most developers. CCUS is therefore not considered standalone in this paper, viewed instead as one particular form of CCS.

[2] European Commission (2019) The European Green Deal COM/2019/640 final

[3] Elkerbout, M. & Bryhn, J. (2019) **An enabling framework for carbon capture and storage (CCS) in Europe: An overview of key issues**

[4] European Commission (2018) A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy COM/2018/773 final

[5] Material Economics (2019) **Industrial Transformation 2050: Pathways to Net-Zero Emissions from EU Heavy Industry**

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production of gas. This method, known as Steam Methane Reformation (or SMR), is the most common and cheapest means of hydrogen production. Capturing the CO_2 could reduce the carbon footprint. But even if CCS were used alongside SMR, it would still not remove all emissions from the process and upstream methane emissions would persist.[6] This means producing hydrogen with SMR and CCS could only have a limited and transitional role in decarbonisation.

CCS development in Europe

Despite a ramping up of political interest, CCS deployment remains in its infancy. There are nineteen commercial projects in operation globally, with another four under construction. Of those in operation, two are in power generation, with the remainder and those under construction capturing emissions from industry. The only operational projects in Europe are both in Norway.[7] At present, geological sequestration of CO_2 in Europe is likely to be developed by a handful of countries in the North Sea region. Although there may be smaller projects in other regions of Europe, the requirements of CCS development and the natural characteristics of this region mean its deployment will be limited geographically. This means European CCS deployment is stuck in a paradox: while only a limited number of countries can access CO_2 storage, it may be needed by many more member states and regional partners. This may explain why the EU has struggled to define a pan-European approach to CCS, and instead allowed member states to development their own frameworks and development strategies.

As far back as 2007 the European Commission offered political and financial support to CCS development. The New Entrant's Reserve (NER300) scheme – a funding mechanism linked to the EU Emissions Trading Scheme (ETS) – provided support for CCS alongside innovative renewable energy projects, while the European Energy Programme for Recovery (EEPR) supported CCS projects in the context of post-economic crisis recovery and promotion of the energy transition. An envelope of €3.7bn was made available for projects that could show the commercial viability of CCS, but ultimately no projects were funded under NER300 and only one EEPR-supported development – a pilot project in Spain – was constructed.[8]

Although there were some design features of NER300 that made it difficult for CCS projects to secure funding, there were also several important external issues, such as overoptimistic CCS cost calculations, technical issues across projects, low public

[6] BEIS (2019) **H2 Emission Potential – Literature Review**, pp.14-16

[7] Global CCS Institute (2019) **The Global Status of CCS: 2019**

[8] Euractiv (24 October 2018), **Post-mortem: Auditors analyse EU's failed carbon capture projects**

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acceptance of CCS (which affected development and permitting in member states), and a perception that CCS had higher financial risk than other decarbonisation options.[9] A low EU ETS price at the time also made CCS financially unattractive, irrespective of NER300 funding opportunities.

Going forward the EU could remain an important source of funding. The Innovation Fund will support demonstration projects for industrial decarbonisation from 2021, while the Connecting Europe Facility (CEF) and Projects of Common Interest (PCI) process could support CO_2 transport infrastructure.[10] The most recent PCI list included five CCS projects, four of which involved co-development and shared access to infrastructure for multiple member states. The European Regional Development Fund (ERDF) and Cohesion Fund – the EU's main tools to advance regional development – could also be used to fund regional CCS clusters.

Norway

Norway began CO_2 removal in the 1990s and has Europe's only large-scale commercial CCS projects, both from natural gas production. The removal of CO_2 from natural gas produced at the offshore Sleipner Vest field began in 1996 and Utgard in 2019, with CO_2 injected in to the Utsira formation. In 2009 the Snøhvit LNG terminal in Melkøya began removing CO_2 from natural gas, which is then reinjected in to the Snøhvit field.[11] Norway's success on CCS development is partly a result of its domestic carbon tax introduced in 1996. It is the only country that has implemented a carbon tax that has supported the business case for CCS during gas production.[12]

Further expansion of CCS for its oil and gas and industry sectors is seen by domestic policy makers as hugely important for Norway's economy and central to its low carbon future.[13] Norway has the second highest volume of geological storage in Europe after the UK,[14] and has positioned itself as the leader in Europe's development of CCS for industry – most notably with the Northern Lights project, which involves multiple oil and gas companies developing an offshore CO_2 storage site west of Bergen.[15] Norway also plans industrial CCS deployment, for example at Heidelberg Cement's Norcem Brevik plant. As well as receiving CO_2 from other countries, Norway plans to export CCS technology and expertise

[9] Unwelt Budesamt (2018) **The Innovation Fund: How can it support low carbon industry in Europe?** p.22

[10] European Commission (2019) Annex VII, C(2019) 7772 final

[11] Norsk Petroleum, **Carbon capture and storage** [accessed 12 March 2020]

[12] Global CCS Institute (2019) **Policy Priorities to Incentivise Large Scale Deployment of CCS** p.5

[13] EU High Level Conference on Carbon Capture and Storage (Oslo, 8-9 September 2019)

[14] IOGP (2019) **The Potential for CCS and CCU In Europe** p.24

[15] CCS Norway, **Transport and storage: Northern Lights** [accessed 12 March 2020]

internationally, with the Technology Centre Mongstad (TCM), currently the world's largest CCS research facility.

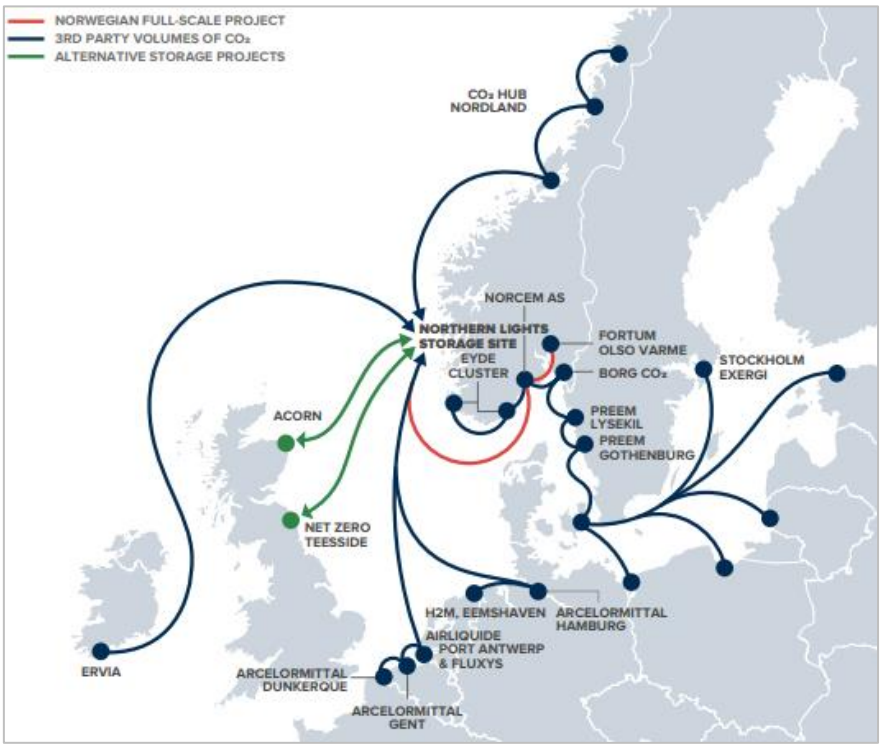

Figure 1: Potential sources of CO_2 for Northern Lights CCS project
Source: Global CCS Institute

United Kingdom

Having tried to develop CCS for power generation on two previous occasions, the UK is prioritising CCS as a tool to help deliver net zero – with a focus on industrial sectors, and the production of hydrogen for industry and domestic heating. CCS and CCUS feature heavily in the government's future plans meeting its climate targets, with the deployment of CCUS at scale during the 2030s important for delivering a 'step change' in emissions reductions.[16] To help enable the development of CCUS, the government's 2020 budget proposed the creation of a CCS Infrastructure Fund and financial support for developing CCS in multiple sites.[17] Existing offshore oil and gas infrastructure in the North Sea is expected to be reused for CO_2 transport and storage help to minimise capital expenditure and engineering requirements. Development is focusing on creating 'low carbon clusters'

[16] HM Government (2019) **Leading on Clean Growth The Government Response to the Committee on Climate Change's 2019 Progress Report to Parliament – Reducing UK emissions**

[17] HM Treasury (2020) **Budget 2020**

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with the co-location of CCUS and hydrogen in existing industrial areas in south Wales, northwest England, and the North Sea coast (Teesside, Humberside, and Scotland). [18]

The Netherlands

In the Netherlands, CCS development is focused on the Rotterdam industrial area, which accounts for 20% of the country's carbon emissions.[19] The leading project, Porthos, would involve the capture and transport of CO_2 from the Rotterdam industrial area for storage in depleted North Sea gas fields.[20] The developers Exxon Mobil, Shell, Air Liquide and Air Products are targeting a start date of 2023. A planned second phase, known as Athos, would also store CO_2 from Dutch industry and possibly other countries.[21] The Netherlands is well positioned to receive other countries' CO_2 for storage, potentially via future pipelines or river-borne tankers – for example, from Germany's Rhine-Ruhr industrial corridor, which would be crucial for Germany's own CCS development due to domestic opposition to onshore storage.

Germany

Development in Germany is being driven by industrial sectors, in particular cement and steel, in the Rhine-Ruhr corridor.[22] But strong public opposition to subsurface CO_2 storage in Germany remains a crucial barrier to development – even though it is not prohibited by national law.[23] CCS would therefore require the transport of CO_2 to neighbouring countries (i.e. Netherlands or Norway) via pipelines or river-borne tankers. In Germany one of the critical barriers has been the failure to disentangle coal from CCS development. For example, a lack of political support and very strong public opposition contributed to utility Vattenfall abandoning development of Germany's only at-scale CCS project – at the Janschwalde lignite power station – in 2011.[24]

Rest of Europe

Elsewhere, future CCS development may be limited by insufficient access to suitable CO_2 transportation options and geological storage sites. The Baltic Sea region could become important for carbon capture because of the predominantly coastal location of industries in chemicals, metallurgy, paper and manufacturing, and its proximity to potential North Sea storage clusters – which could make CO_2 transport in seaborne tankers a viable option.

[18] See: Global CCS Institute (2019) **The Global Status of CCS: 2019** p.47

[19] Zero Emissions Platform (July 2018) **Role of CCUS in a below 2 degrees scenario**

[20] **Rotterdam Porthos CCUS Project** [page accessed 1 November 2019]

[21] European Commission (2019) **Candidate PCI projects in cross-border carbon dioxide (CO2) transport networks in view of preparing the 4th PCI list** [accessed 17 March 2020]

[22] Argus Media (26 September 2019) **German industry seeks CCS opportunities**

[23] Navigant (2019) **Gas for Climate – The optimal role for gas in a net zero emissions energy system** p.129

[24] Reuters (5 December 2011) **Vattenfall drops carbon capture project in Germany**

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Facilities in southern Europe, such as Romania, may be able to tap into storage sites elsewhere by transporting CO_2 via the Black Sea and Mediterranean, but the extent to which a pan-European CCS supply chain (via pipeline or tankers) can be developed is unclear.

Requirements for advancing CCS development

Despite the recognition that CCS could play a role in delivering climate neutrality in the EU by 2050, delivering the optimal conditions for the development of CCS id not yet certain. Europe is in a strong position to lead the world through defining and regulating CCS to ensure that its deployment contributes to the acceleration of deep decarbonisation and climate neutrality targets. Europe has strong regulatory bodies and frameworks that will be indispensable in regulating the safe delivery of CO_2 storage. It also has growing interest in CCS from industrial emitters, local and regional governments, and civil society, as well as significant engineering supply chains and expertise. But without the right political, economic and social conditions – and concerted government and European Commission policy support – CCS will not be developed. Equally, project developers and companies who are calling for CCS will need to approach the challenge differently from the way they have done so in the past.

CCS development must be targeted and restricted to where there are no alternatives

Although CCS could have a potentially significant role in future, it is not a one-size-fits all solution for reducing emissions. Because CCS is technically complex and costly (and does not change production processes in itself) it will only ever be deployed in a small number of geographic areas and end-use sectors. The nature of its deployment will ultimately be determined by geography and geology as well as the economics of its application, with specific requirements needed for capture technology, and CO_2 transport and storage options. Policymakers and developers must understand CCS as a tool of last resort in decarbonisation efforts and, therefore, restrict deployment to sectors with few other alternatives (such as capturing residual emissions in hard-to-decarbonise industrial sectors) as part of broader efforts to reach climate neutrality. It must also be understood as an infrastructure category in itself, rather than a simple 'add-on' to sources of CO_2 emissions, because of the complexity and scale of its development pathway.

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CCS as a decarbonisation tool of last resort

Adhering to the EU's waste hierarchy and 'efficiency first' principle is fundamental in reaching mid-century climate neutrality.[25] This means other methods of reducing CO_2 emissions should be pursued first where possible, including electrification, fuel switching, energy efficiency and material efficiency. The deployment of CCS is most likely to play a role in those sectors and applications where it can be shown that there are no alternative CO_2 mitigation options such as electrification or low-grade heat recovery.

Emitters need to map out the pathways for their operations that will require CCS under climate neutrality, either as a means of transition or as a permanent technological change. Decisions on infrastructure requirements will then need to be made in line with the final aim of being climate neutral. Alongside this, both private and public actors need to increase research and innovation to expedite this transition, with a regulatory and governance process developed in parallel to ensure CCS development does not drift from its intended use.

While CCS could offer more value in heavy industry than in power generation, it will not always be a suitable choice. For example, the advent of electrification and hydrogen for steelmaking could make CCS unnecessary. Similarly, chemicals have a range of alternative mitigation options. There is, however, a broader consensus that it will be very difficult to fully decarbonise the cement sector without CCS.[26]

CCS should be understood as an infrastructure category in itself

CCS has proved more difficult to develop than was initially assumed during the first development wave in the 2000s. A key factor behind this was that policy makers and advocates regarded CCS as a technological addition to CO_2 emitting processes and operations, rather than an infrastructure class in itself. The assumption was that CCS would simply be added to existing facilities – much like scrubbers or capture technology to reduce air pollution emissions for compliance with the Industrial Emissions Directive (IED) – rather than needing to be developed separately.

Industry actors were also overly optimistic in the past about the cost and speed at which CCS could be deployed at-scale, while the sensitivities of geological storage and infrastructure requirements were under-appreciated. For example, in 2008 the energy ministers of the G8 group of leading economies gave their support for the launch of "20 large-scale CCS demonstration projects globally by 2010 […] with a view to there being

[25] European Commission (25 September 2019) **Energy efficiency first: accelerating towards a 2030 objective of 32.5%**

[26] Material Economics (2019) **Industrial Transformation 2050: Pathways to Net-Zero Emissions from EU Heavy Industry**

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broad deployment of CCS by 2020."[27] Similarly, the UK government regarded the capture of CO_2 from power stations as "the greatest technical challenge" facing CCS development rather than storage or transport issues.[28]

All elements of the CCS supply chain – capture, transport, and storage – are interlinked and cannot be developed in isolation from one another. This means CCS can best be conceptualised as a network infrastructure and not just a simple add-on. The previous focus on CO_2 capture underplayed the need to have integrated planning and policy for the CCS chain, and the specific obstacles that CO_2 transport and storage infrastructure may face.

Geographical and geological restrictions will determine deployment

CCS can only be used in places where the geography of capture, transport and storage are all suitable. Targeting the most suitable geographies and geologies is, therefore, key to maximising outcomes. Following previous failures to develop 'point-to-point' CCS projects (with a closed, integrated system from emitter to a storage site), a clustered form of development is now favoured in Europe.[29] Economies of scale can be achieved when CO_2 capture and transport infrastructure costs are shared across industrial centres and clusters, rather than being carried by a single emitter.[30] Clusters also reinforce the understanding of CCS as a (network) infrastructure working across several sectors.

Decisions as to which clusters to prioritise will need to be informed by the location of the most suitable geological storage sites, which are a scarce resource in Europe. The most promising and scalable projects in Europe are found in the UK, Netherlands and Norway. Each of these countries has good access to suitable subsea geological storage, high density of CO_2 emitting industries, and existing infrastructure that can be repurposed if needed. Some aspects of the proposed development models for CCS, such as industrial clusters, favour particular member states and types of industrial activity. For example, industrial activities such as petrochemicals, refining, and steel production tend to be clustered because of access to energy and fossil fuels, raw materials, and heavy transport infrastructure (both land and water). By contrast other industries, such as cement production, are more dispersed and may not benefit from the clustered development model – meaning other solutions will need to be found.

[27] **Joint statement by the G8 Energy Ministers** (8 June 2008)

[28] DECC (2008) **A framework for the development of clean coal: consultation document** p.20

[29] Zero Emissions Platform (2016) **Identifying and Developing European CCS Hubs**

[30] BEIS (2018) **The UK Carbon Capture Usage and Storage deployment pathway: an action plan**

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Specific CCS technology choices will be crucial

Clear choices will also need to be made about the type of CO_2 capture technologies that emitters use. There is a range of technologies for capturing CO_2 from industrial processes, fossil fuel combustion, and chemical processes, which are in varying stages of development. [31] But not all of these capture technologies have the same applicability, scalability, or economics. In choosing which to support a part of the first generation of capture technologies, policy will have to bear in mind that the goal is climate neutrality by 2050 and avoid any path dependency or lock in that would compromise that goal.

For example, the optimism around carbon capture and utilisation (CCU) must be viewed with some scepticism. Although there is some commercial and industrial demand for CO_2 the scale will be far less than the potential volumes of CO_2 that could be captured if CCS were to be deployed across industrial clusters.[32] In many cases of utilisation, the CO_2 may be released back into the atmosphere at a later stage. This matters for infrastructure development choices, as business models, investment and financing, and government regulation must be mindful of how current CCS technology fits with the emissions requirements of climate neutrality in 2050.

Heavy industry sectors must be engaged in the CCS development process

With CCS most likely to be deployed for industrial processes in future, it is imperative that these sectors are properly engaged on an equal or greater footing than fossil fuel companies. Compared to operators of coal and gas-fired power stations, industrial emitters theoretically have more of a stake in paying for CCS as they have fewer options to transition away from a reliance of fossil fuels, or CO_2 emissions from industrial processes.

Previous prioritisation of the coal sector cannot be repeated

One of the most significant errors of CCS development in the 2000s was prioritising deployment of CCS in the coal-fired power generation sector. For example the European Commission's 2006 'European Strategy for Sustainable, Competitive and Secure Energy' called for "carbon capture and clean fossil fuel technologies [to] be encouraged" across the energy sector. [33] This narrow approach relegated consideration of broader applications of CCS, in particular engagement with heavy industry. It also meant that the development of CCS projects relied on utilities and the coal sector while CO_2 storage

[31] IPPC (2005) **Special Report on Carbon Dioxide Capture and Storage**

[32] Wuppertal Institute: Infrastructure Needs for the Decarbonisation of Industries (3 December 2019 – Essen, Germany)

[33] European Commission (2006) Green Paper: A European strategy for sustainable, competitive and secure energy COM/2006/105

depended on proactive action from oil and gas companies – all of which had vested interests in either delaying CCS deployment or preventing its emergence altogether.

Although vested interests of CO_2 emitters are all-too-frequently present in energy and climate policy debates, policy makers can proactively engage other sectors and stakeholders that seek to accelerate the transition to net zero rather than hold it back. A broader social dialogue and public interest case for CCS deployment would lower the risk of regulatory and policy capture and ensure that the creation and maintenance of a social license to operate is prioritised by regulators and industrial actors alike.

When it comes to coal-fired power plants, the power generation sector generally has more and easier options to decarbonise than heavy industry: simply, one form of generation (fossil fuels) can be replaced with another form (renewables). The strong growth in renewables and falling generation costs also means there is no business case for building new coal-fired generating capacity, even if was CCS ready. With over 90% of the EU's coal-fired generating capacity already running with higher operating costs than renewables, retrofitting with CCS makes little economic sense.[34]

Heavy industry must also be proactive on development

Despite understanding that CCS could be critical for heavy industry in its transition to climate neutrality, few industry players are actively and publicly calling for rapid CCS deployment or have made substantial investments in specific projects to date. In November 2019, the European Commission published a report on industry decarbonisation by the High-level Group on Energy-intensive Industries in which the focus on hydrogen far outweighed any mentions of CCS.[35] Although there was a set of specific recommendations on scaling up hydrogen, not a single policy ask about CCS was included – despite potential CCS deployment for industrial decarbonisation and CCS being crucial for hydrogen production using natural gas via SMR.

By focusing solely on hydrogen as a direct replacement for natural gas in an industrial process, heavy industry is in effect shifting the 'transition responsibility' upstream to the natural gas suppliers. In effect, the carbon problem is being outsourced to the gas supplier, rather than the CO_2 emitter. Although the gas industry must play its role in decarbonisation, industrial emitters must take the lead and recognise their own responsibilities. Several factors may be holding back industry engagement including the lack of a business case (in the absence of a higher carbon price), concerns about the

[34] Carbon Tracker (2020) **How to waste over half a trillion dollars: The economic implications of deflationary renewable energy for coal power investments**

[35] European Commission (2020) **Masterplan for a Competitive Transformation of EU Energy-intensive Industries Enabling a Climate-neutral, Circular Economy by 2050**

availability and access to CO_2 transport and storage infrastructure, a lack of trust in the oil and gas sector to deliver this infrastructure at an acceptable cost, and the generally low public acceptance of CCS. Although there is some merit to these concerns, there is also a risk that heavy industry players are using these factors as a cover for inaction on deep decarbonisation.

Heavy industry can be a driver of CCS cost reductions

Industrial emitters have a role to play in stimulating quicker CCS deployment by exploring ways to reduce the cost of CCS technology, as well as finding alternative methods of reducing their process emissions. These companies will also need to make significant capital investments to fit CO_2 capture. Although heavy industry as whole has not been active on developing CCS, there are several companies in the cement and steel sectors that have signalled interest in CCS development. These companies could play a role in reducing technology and development costs by undertaking research and innovation and providing examples of best practice for policy makers.

For example, Heidelberg Cement has an emissions reduction target of 30% by 2030 from 1990 levels [36] and is a member of the Brussels-based CCS advocacy platform Zero Emissions Platform (ZEP). It has also developed the CI4C (Cement Innovation for Climate) joint research body with other companies Buzzi Unicem, Schwenk Zemet, and Vicat.[37] Similarly, in the steel sector ArcelorMittal has signed an agreement with Norwegian energy company Equinor to cooperate on the Northern Lights CO_2 storage project. There are also some examples of nascent industrial cluster development that show industrial actors are recognising the need to decarbonise and understand the most efficient way of doing so. In the UK, the Teesside Collective industrial cluster is formed of five major industrial companies, with the local Tees Valley Combined Authority playing a coordinating role. [38] Similarly, the Porthos CCS projects in the Netherlands involves multiple industry actors around the port of Rotterdam.

[36] Heidelberg Cement (13 May 2019) **HeidelbergCement first cement company to receive approval for science-based CO2 reduction targets**

[37] Heidelberg Cement (11 December 2019) **Cement Producers have founded an Oxyfuel Research Corporation**

[38] **Teesside Collective** [webpage accessed 14 May 2020]

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Advocates of CCS must make a public interest case for its development

While the previous focus on CCS for coal-fired power generation had consequences for technical and economic appraisal of CCS development, it was also a key issue for public support. CCS became deeply unpopular with NGOs and the broader public and was regarded as a 'a fig leaf' for continued coal-fired generation, rather than something that would contribute to climate mitigation. The failure to develop CCS in Germany is a clear example of the consequences of not securing adequate public support for CCS.

If CCS is to have a viable future in Europe, its proponents will need to build a strong public interest case for it and gain a 'social licence' to operate – especially from local communities in areas that will see CO_2 infrastructure development, and if developers want continued support through public funds. This will require CO_2 emitters to demonstrate how CCS can provide high value outcomes that align with climate goals. It will also require companies to secure the acceptance and approval of the local community in which they operate, and other stakeholders in civil society.

Extractive industries have often struggled to maintain sustained dialogue or collaboration with affected communities, beyond approaching social responsibilities as something that is to be managed and measured relative to performance and targets.[39] A way of engaging the broader public would be to situate CCS within the ongoing political discussions on the Just Transition and tackling climate change. Analysis of the potential social and labour market consequences of mid-century climate neutrality are at an early stage, but there is a high degree of overlap between possible sectors that could use CCS and ones that are likely to be operationally challenged by climate neutrality.[40]

Oil and gas sector involvement must be transparent and managed as part of the transition to climate neutrality

Europe's oil and gas industry is likely to be a key player in future deployment of CCS. It already has expertise in the handling and processing of CO_2 and other gases, operating pipelines, and working with offshore geological formations. It has considerable financial resources, and an imperative to become aligned with climate neutrality.[41] Other actors such as gas transmission operators are also likely to play a role because of their expertise

[39] Parsons, R., and Moffat, K. (2014) Constructing the Meaning of Social Licence, *Social Epistemology*, 28 (3-4), 340-363

[40] See for example: Engineering Construction Industry Training Board (2020) **Towards Net Zero: The implications of the transition to net zero emissions for the ECI**

[41] E3G (2020) **Pathway to a Climate Neutral 2050: Financial Risks for Gas Investments in Europe**

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in gas handling and pipeline infrastructure. Europe's only commercial CCS projects (both in Norway) involve the capture of CO_2 from natural gas production – as a result, these and other companies in the oil and gas industry are in leading positions for future development.

This is especially the case in the UK and Norway where CO_2 is likely to be transported in repurposed natural gas pipelines and stored in depleted offshore gas fields. There is also a strong climate imperative for oil and gas companies to help deliver CCS deployment. They have made a substantial and long-term historic contribution to climate change. The oil and gas industry must clearly set out its role in the net-zero transition – whether with CCS or other means of decarbonisation. The risk, however, of relying on the oil and gas sector to deliver CO_2 storage is that CCS development falls into a similar trap to the one described above with the coal sector.

Most of the oil and gas sector is not perceived as being serious about addressing CO_2 emissions, with investment in CCS many times smaller than that in oil and gas production. In 2019, CCS and renewables together accounted for just 0.9% of total capital expenditure across the oil and gas industry, while between 2015 and 2018 only 37% of total CCS and CCUS-related investment was made by oil and gas companies.[42] Advocates of CCS must also be transparent about the scale of challenges facing development. The oil and gas sector has previously suggested an absence of policy support from the EU and national governments is the key problem; yet there remain huge uncertainties around its ambition, and issues such as technical requirements, geographic restrictions, development costs, and liabilities of asset operation and CO_2 handling.[43]

Policy makers must develop frameworks to support the development of CCS infrastructure

Each of the requirements listed above – from choosing sectors and geographies to managing different actors – requires policy makers and regulators to be much more proactive on CCS delivery than they have been previously. A crucial first step is for countries such as the UK and Norway to require audits of oil and gas fields and associated infrastructure to quantify how much geological storage can be accessed and which infrastructure could be repurposed for CCS over the next decade. This must be linked to oilfield decommissioning policies, to ensure infrastructure that may be reused for CCS is not scrapped. The Northern Lights project in Norway is an example where existing

[42] IEA (2020) **The Oil and Gas Industry in Energy Transitions – world energy outlook special report**

[43] See for example: Global CCS Institute (2019) **Lessons and Perceptions: Adopting a Commercial Approach to CCS Liability**

infrastructure will be reused for CCS, and the UK has also consulted on the reuse of platforms and pipelines.[44]

Moving quickly to ensure CO_2 transportation and storage infrastructure is in place first is also critical to unlocking industry engagement. CCS currently faces a 'chicken and egg' problem as industry is unwilling to commit to the capital investments required to start capturing emissions in the absence of transport and storage infrastructure to dispose of their emissions. At the same time developers and policy makers are failing to deliver transport and storage infrastructure in the absence of industry commitments to capture emissions. Delivering infrastructure and seeing projects being successfully advanced and implemented would also help in demonstrating infrastructure safety, showcasing real action from industry, and building public and civil society trust in CCS.

Emitters will not invest in CO_2 capture unless there are incentives or requirements for them to do so and CO_2 transport and storage infrastructure available. But, at present, there is no incentive to develop CO_2 transport and storage infrastructure ahead of a strong signal that growing volumes of CO_2 will be captured and supplied . There needs to be a public policy framework to address this, which will provide security for both those capturing CO_2 and those transporting and storing it. The specifics of this framework will need to be based on the intended scale, scope, and model of CCS development, looking at key issues such as the role of public finance, access charges for emitters, and optionality for transport network expansion.

EU leadership will be crucial for regional clusters

At the EU and international level, successful development will depend on key countries such as the UK, Norway, and the Netherlands taking the lead with support from the EU. These countries will need to define development plans for CCS in industrial and energy policy strategies, setting out how they expect to share costs with industries and milestones for delivering CCS. They will also need to engage with local and regional governments and civil society, as well as considering how CCS interacts with other infrastructure as part of the transition to climate neutrality. [45]

The EU should also look at developing common governance frameworks for all parts of the CO_2 chain, allowing third party and/or international access to infrastructure, addressing liability issues and uniform regulation on the technical specifics of infrastructure and storage facilities. The modification of the international London Protocol in 2019 was an important step towards allowing the cross-border transport of

[44] BEIS (2019) **Consultation: re-use of oil and gas assets for carbon capture usage and storage projects**

[45] E3G (2019) **EU Energy System Decarbonisation Policy – Breaking the Logjam**

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CO_2 for sequestration, but the EU needs to ensure this is reflected in its own CCS policy frameworks.[46] As of 2019, only six contracting countries had ratified the change to the Protocol (the UK, Netherlands and Norway among them).[47]

But the EU will need to facilitate cooperation to make sure CCS can work for all member states (particularly as there is a range of national approaches to CCS[48]), but also recognise that not all states may want to use CCS for their domestic transition to climate neutrality. Member states without their own geological storage will need access to CO_2 infrastructure (whether via pipelines or seaborne tankers) to transport it to other countries. Norway's Northern Lights CCS project stands as a forerunner of this development model.[49] But those countries that cannot develop their own storage sites or access other member state's sites may need to be appropriately supported by the EU, as part of wider measures for transforming energy and industrial sectors and the just transition.[50] More research will therefore be needed as to what policy measures be required for 'CCS equity' in access to infrastructure and storage, but also what support can be provided for regions and countries where CCS cannot be developed at at-scale.

Conclusion

The European Green Deal has put mid-century climate neutrality at the heart of the EU's future economic, climate and energy policy – and delivering this target will require a fundamental restricting of how many elements of Europe's economy functions. CCS can play a role in this deep decarbonisation – but it must not be developed at any cost, and delivering climate neutrality must remain the guiding principal of energy, economic and industrial policy. Policy makers have an opportunity to get the development of CCS correct in this decade, learning from mistakes of the last CCS development attempt. Designing the correct policy and regulatory frameworks depends on a more diverse set of actors being consulted in the process, with the deployment of CCS properly targeted and focused on specific end uses within certain sectors. But its development must fit within the broader and ultimate aim of delivering climate neutrality.

[46] International Maritime Organisation (14 October 2019) **Addressing barriers to transboundary carbon capture and storage**

[47] IOGP (2019) **The Potential for CCS and CCU In Europe** p.31

[48] Navigant (2019) **Gas for Climate – The optimal role for gas in a net zero emissions energy system** p.129

[49] CCS Norway, **Transport and storage: Northern Lights** (accessed 14 November 2019)

[50] European Commission (2019) **Financing the green transition: The European Green Deal Investment Plan and Just Transition Mechanism**

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About E3G

E3G is an independent, non-profit European organisation operating in the public interest to accelerate the global transition to sustainable development. E3G builds cross-sectoral coalitions to achieve carefully defined outcomes, chosen for their capacity to leverage change. E3G works closely with like-minded partners in government, politics, business, civil society, science, the media, public interest foundations and elsewhere.

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