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Policy Briefing

Reframing the Value Case for Carbon Capture and Storage

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Key Points

In meeting long term climate ambitions at regional and national levels, there is a need **to retain and ultimately grow high value jobs and production activity across the economy.** This is reflected in the **'Just Transition' element of the 2015 Paris Agreement** and will always be a preferable outcome to job offshoring/GDP loss and not meeting targets in the short and long term (UNFCCC, 2015, p4). The inevitable consideration of how best to value alternative approaches to deliver against these ambitions requires a broadening of focus from project cost metrics to a political economy and ultimately wider societal perspective.

A key conclusion of the current study is that the most useful and easily communicated way of measuring a broader economic impact of Carbon Capture, Utilisation and Storage (CCUS) investments and associated government support is in terms of the expenditures required to **sustain existing and/or create new jobs and/or other outcomes valued by society.** Such a focus is likely to be particularly important in the UK context of the 2019 **HM Treasury Spending Review**, where all investment projects are likely to be judged on the basis of contributing to prosperity going forward and value delivered per pound spent. This is an important context for the **CCUS Delivery and Investment Frameworks** planned for 2019 in the **UK Government's CCUS Action Plan**

Economic multiplier methods enable a transparent and rigorous initial assessment of **how many direct, indirect and induced supply chain jobs may be sustained and/or created** where a solution like CCUS is introduced to allow industries to decarbonise and continue to grow in key regional locations.

For example, in 2014, there were just over 1,900 full-time equivalent (FTE) jobs in the **Scottish Petroleum and Petrochemicals industry.** Through supply chain linkages the **total number of Scottish FTE jobs supported by the industry's activity was over 6,650**. In the same year, the industry serviced just over £1.4 billion in (non-household) final expenditure, implying an expenditure requirement per job of £212,246. However, this is only Scottish jobs. The number of jobs supported will grow, and thus the final expenditure requirement in the Scottish industry is reduced, if the wider UK supply chain is considered.

It is also important to note that, given current national accounting processes, any Scotland-focussed analysis crucially excludes consideration of **up-stream linkages to the off-shore oil and gas extraction sector.** In national accounting terms the off-shore sector is located in the extra-UK Continental Shelf region. Thus, multiplier impacts of the Petroleum and Petrochemicals and any other Scottish industry that has direct or indirect up-stream supply chain linkages to the off-shore sector will be underestimated.

This also means we cannot directly estimate how the oil and gas extraction industry may impact on CCUS scenarios, where it is likely to provide crucial capacity in terms of the transportation and geological storage of captured CO_2, and could, thus, be a key element of considering the political economy value case for CCUS in Scotland and the UK.

On the other hand, we can consider the impacts of the **Scottish on-shore 'Mining Support' industry**, where just over 26 thousand Scottish FTE jobs were directly located in 2014. But **when indirect and induced supply chain linkages are taken into account the total number of Scottish jobs supported by the on-shore**

industry is 44,284. This maps to £3.84 billion in expenditure on the industry's output, where 11.5 FTE jobs required throughout the Scottish supply chain per £1milion spent. The required expenditure per job is thus just £86,720.

Generally, the metrics reported here support the argument that the key route to delivering value from CCUS to the political economy in a Scottish context will be via developing carbon transport and storage infrastructure and service delivery. To do so would build on existing strengths and value existing in Scotland's off-shore, on-shore and supply chain skills and physical capacity and infrastructure. It would help secure the 'just transition' that Scotland seeks, particularly by sustaining and exploiting the relatively high economic multiplier and low expenditure/activity level required per job in the on-shore mining support industry. The return to resources required in government intervention to enable and/or help develop Scottish CCUS can be assessed by building on the expenditure per job metrics reported here where information is available on the government spending required to enable CCUS in any one sector. This would involve resetting in terms of the type of 'cost per job' (CPJ) metrics recommended by HM Treasury for the CCUS scenario(s) under consideration.

1. Introduction – reframing the value case for CCUS

Our study (Turner et al., 2019) has been conducted with reference to, and aims to add to, the evidence base provided through the recent CCUS Cost Challenge Taskforce report (CCUS Taskforce, 2018, p.24) - subsequently reflected in the UK Government's CCUS Action Plan (BEIS, 2018, p.29)- and a Zero Emissions Platform report "The Role of CCUS in a Below 2 Degrees Scenario" (ZEP, 2018). We have reviewed a range of studies on the economic impacts of CCUS and conducted a new preliminary analysis of the potential jobs multiplier impacts associated with CCUS for Scotland. At this stage it is thought that the prospects for carbon utilisation to contribute to climate targets is relatively low in terms of volumes when compared with geological storage, but utilisation should still be explored as a potential value-adding process.

Taking an economy-wide focus is important if the low carbon transition is to be a 'just transition', as set out in the Paris agreement, where carbon reduction needs to be achieved without hindering national priorities on job creation and the quality of jobs (UNFCCC, 2015, p4). In late 2018 the Scottish Government announced the establishment of a **Just Transition Commission** and, thus, needs to adopt a broader political economy focus in considering how both economic and climate objectives can be achieved in a cost effective way in the context of a broader set of societal outcomes. The other key context for considering a political economy value case is the forthcoming **HM Treasury Spending Review**, where public investment projects are expected to be assessed in terms of their contribution to prosperity generally, and value delivered per pound of spending in particular. This will impact decisions in 2019 under **CCUS Delivery and Investment Frameworks** set out in the **UK Government's CCUS Action Plan** (BEIS, 2018)

The key insight of the current study is that the most useful and easily communicated way of measuring the economic impact of CCUS investments and associated government support is in terms of the expenditures required to **sustain existing and/or create new jobs and/or other outcomes valued by society.** The inevitable concern over value for government money leads us to propose the translation of economic multiplier outcomes to the type of **'cost per job' (CPJ) metric** commonly used in the social **Cost Effectiveness Appraisal (CEA)** recommended by HM Treasury where full social cost-benefit analysis is not feasible. CEA metrics such as CPJ are perhaps most commonly applied in the context of creating new jobs (where a range of costs relating to different activities involved may be incurred).

Here, we initially focus on how basic multiplier measures provide insight on the number of existing jobs supported by potentially CCUS-relevant industries that may be sustained if CCUS enables a continued low carbon future in Scotland. We set the results in terms of **'expenditure per job'**, that focuses on the **industry activity levels required to sustain each**

job supported. We use an approach that is easily adapted to consider (government resource requirements and spending) 'cost per job' as and when government spending requirements for specific CCUS projects are known.

Moreover, consideration of **potential additional jobs** associated with any subsequent expansion in industry activity **enabled by introduction of carbon capture, utilisation and/or transport and storage** could similarly be considered using multiplier analyses. On the other hand, consideration of multiplier impacts associated with potential development and CCUS deployment scenarios going forward may be better informed through simulation within more sophisticated economy-wide modelling frameworks.

Crucially, taking an economic multiplier and CEA approach permits the value of CCUS to be presented in terms of metrics that are compatible with HM Treasury approaches. Additionally, expressing value in these terms 'opens the door' to extending in line with approaches used in fuller 'Social Cost-Benefit Analyses' (SCBA) to better measure and compare societal value achieved. This is likely to apply where CCUS, linked solutions such as hydrogen development, and any government support activity is likely to be spatially distributed and/or directed across different regions and/or industry clusters.

2. Existing studies on the economics of CCUS

We reviewed a number of studies that have considered the economic case for CCUS. These ranged from earlier techno-economic studies, mainly carried out prior to or not long after the 2015 cancellation of the second competition for UK government support for CCUS, to more recent economy-wide studies attempting to include, or focussing primarily on, quantifying societal value. We have drawn on this review, alongside our own analysis for Scotland (see below) to arrive at the key points set out above.

2.1 Techno-economic studies

This type of study focuses on assessing deployment costs and cost reduction potential. In that sense the sort of analysis they contain is critical in building up a credible evidence base for considering the investment case for CCUS from a wider societal perspective. In particular, this type of analysis can inform decision making on the extent of government support that might be needed to bridge the investment gap, and these studies attempt to quantify that level of support.

They do not however consider the potential for feedback loops (for example around how risk is priced) between the techno-economic estimates of project costs and the extent and nature of wider economic ripple effects of those projects. The case for government support is likely to depend upon more than evidence of deployment costs – the higher-level economic ripple effects of investment are of significant interest to public investment decision-makers. Moreover, these techno-economic studies focus on the present costs and values associated with CCUS deployment and do not consider key issues *now* associated with CCUS, such as links to hydrogen deployment to decarbonise a range of 'hard to reach' sectors such as domestic heat.

2.2 Extension studies

This second type of study takes the analysis further by assessing not only the direct costs of CCUS deployment and the value of avoided CO_2, but extending to consider the 'knock on' value to the wider economy triggered by CCUS investments (and, by implication, any associated government support). The overall approach remains one of ultimately aiming to inform fuller cost-benefit analysis, but the scope of costs and benefits is wider than in the techno-economic studies in extending this to the 'social' focus of public policy evaluation, for example through consideration of GDP/ GVA and preservation of existing or creation of new jobs.

In these studies, existing national accounting and/or other evidence on economy-wide multipliers (for example, for the oil and gas industry) are used to measure and understand the potential indirect effects of CCUS roll-out on those industries that will buy and sell goods and services from/to the CCUS-relevant sector. A commonly used termed in this regard 'linked economies'. A key feature is that the extension studies follow techno-economic studies in attempting to identify a range of costs and benefits associated with particular scenarios for CCUS roll out *and* linked activities that may drive the need for CCUS. In terms of the latter, in a UK context this is mainly focussed on future potential scaled roll out of hydrogen systems to decarbonise industry and domestic heating, but also the potential for CO_2 enhanced oil recovery (EOR).

2.3 Economy-wide studies

In contrast, all but one of the reviewed focuses more generally on identifying and measuring economy-wide metrics that can be used to frame policy arguments and provide the basis for developing narratives around CCUS. This is in so far as they describe what impacts on key macroeconomic variables such as GDP and jobs may be, and to show what the breakdown of economic impacts may be across and within different sectors of the economy. They use multiplier metrics based, where possible, on publicly available national accounting data to understand and communicate these economy-wide effects and how study outcomes may be used to help underpin and formulate economic narratives. This is with particular focus on considering the role of CCUS in a low carbon transition that is perceived to be 'fair' by those concerned with jobs and economic value generation.

But this sort of analysis can be approached in two linked ways or steps, the first of which is currently more developed than the other. As outlined above, this first step is in considering and understanding broader measures of 'macro' economic activity as building up from the network of what has been referred to above as linked economies.

The second step, which has only really been attempted so far for the UK in the context of CCUS linked to EOR, reported in Turner (2015), referred to here as the CO_2-EOR study, is to build in the techno-economic and extension studies above through scenario analysis with fuller application of economic multipliers. This involves economic multipliers being reported as broader economic outcomes linked to required government spending associated with enabling and deployment of CCUS.

The outcome multipliers reported in the CO_2-EOR study (see Table 1 below) focus on the economic stimulus triggered by each £pound of government spending in supporting CCUS deployment specifically in electricity generation *and* any stimulus following market activity enabled as a consequence of demand for oil recovered). The resulting headline multiplier results focus on how the total economic stimulus can be related back to the government support 'trigger' or enabler of the expansion. Given that this is the only study that has implicitly moved through the range of steps proposed here, it is one that we return to in providing a more explicit example of how the steps proposed in this paper may develop.

Proposition: a new metric for assessing societal economic value associated with low carbon solutions?

The CO_2-EOR multiplier study provides a crucial type of insight from the perspective of public policy decision makers. It implicitly focuses on stating metrics in terms that could potentially inform decisions around inevitable government spending/support for CCUS activity and other decarbonisation options that this enables.

What the original CO_2-EOR study does not do is explicitly translate these multiplier outputs to the type of 'cost per socially valued outcome' that could directly feed the type of social Cost Effectiveness Analysis (CEA) recommended in the HM Treasury 'Green Book' as a simpler form of SCBA. However, this is simply done, for example in Table 1 by inverting the 'implied government intervention multiplier' (GDP generated per £ of government spending) from the CO_2-EOR study. That is, the multiplier reports the outcome (£million GDP) per £1m of spending. Inverting it (£1 divided by the multiplier value) gives us the CEA focus on the cost or spending required to realise the valued outcome (GDP in £), rather than the multiplier language of outcome per £ of spend. Note that we use the example in the table to demonstrate

Table 1. CO_2-EOR study 'Implied government intervention GDP multipliers' expressed in CEA 'cost of valued outcome' metrics

Scenarios	Implied government intervention multiplier - GDP (£ per £)	Implied public cost per £ of GDP
1. Off-shore wind	1.52	£0.66
2. Coal-CCS	1.16	£0.86
3. Coal-CCS with CO2-EOR	3.94	£0.25

the principle rather than attempting to provide an applied example (i.e. we do not attempt to argue that Coal-CCUS is of continued relevance).

3. New economics multiplier evidence and metrics for Scotland

Interactions and interdependencies across the economy can be analysed using input-output (IO) tables, produced as part of national accounts in most industrialised nations under the UN System of National Accounts. IO tables basically report what each industry buys from all other domestic sources, and what industry and final demands (including exports) it sells its outputs to.

We used the published Scottish IO tables for 2014 to conduct an initial analysis of the multiplier effects of economic activity spurred by CCUS across sectors in the Scottish economy and to make a first attempt at relating multiplier results to the type of CEA metric proposed above. We adopt the same methods as detailed in Turner et al. (2018b). Here we begin by presenting employment multiplier analyses for three industry examples. The first is on-shore support for mining activities which, in Scotland, largely equates to the off-shore oil and gas industry. The other two are potential important capture industries, iron and steel production, and what we have as a combined 'petroleum and petrochemicals' sector in the Scottish IO tables.

In considering which existing industries would play a role in delivery of CCUS, we should focus attention on the off-shore oil and gas industry as a key potential actor in delivery of a CCUS system in Scotland (and the UK). This is not possible as the off-shore sector is not actually recorded as part of the Scottish national accounts. This has two key implications. First, the multipliers for any other industry (including the iron/steel and petroleum/petrochemicals examples selected) will not include up-stream impacts in the off-shore sector. Second, we cannot fully consider the impact of the off-shore sector. This is an important omission: for example, our previous work for the UK shows that every direct off-shore oil and gas job supports on average another ten indirect supply chain jobs across the UK economy (Turner *et al*. 2018a). Many of these direct and indirect jobs will be located in Scotland. However, at this time we cannot provide an analysis given the industry's location in an additional accounting region referred to as the UK Continental Shelf. This issue is discussed and explored in more detail in a fuller technical report of this project (Turner et al., 2019). On the other hand, this second omission could be partly overcome by taking the on-shore Scottish 'Mining Support' industry as something of an initial 'proxy' given that the majority of its output goes to 'rest of UK' export demand dominated by the off-shore sector.

More generally, the three sectors we have chosen to highlight (using the 2017 issue of the Scottish input-output tables for 2014) here only represent part of the story in terms of the wider economic impacts of potential economic activities around CCUS in Scotland, with further and more detailed study recommended. There

Table 2. Level of indirect & induced full-time equivalent (FTE) employment generated across the economy per £1m of final demand expenditure for industry output

CCUS-relevant sector	Direct employment	Indirect and induced employment	Employment-output multiplier(Jobs per £1million)	Implied expenditure per job
	Jobs per £1million of output to meet final demand			
Onshore support for oil and gas extraction	5.83	5.71	11.53	£86,720
Petroleum and petrochemicals	1.26	3.46	4.71	£212,246
Iron and steel	2.47	4.04	6.51	£153,647

is some additional analytical content in the new Scottish work presented here. Our previous analysis for the UK has focussed only on indirect multiplier effects via goods and services purchases by industries. The Scottish input-output tables allow us to extend consideration to further rounds of multiplier impacts through induced supply chain impacts generated through employment of labour and Scottish household spending funded by wage incomes.

In Table 2 we focus on the total direct, indirect and induced (via household spending funded by wage income) employment generated by each £1m of expenditure on the output of each of the three key CCUS-relevant sectors identified above. These sum to give the total 'output-employment' multiplier.

The most common use of this type of multiplier is to apply it to final demand served by the industry in question to consider the total number of jobs supported throughout the wider economy. In the case of the 'on shore support for oil and gas extraction), final demand was £3.9billion (in basic/factory gate prices) in 2014, and application of the employment-output multiplier tells us that 44,284 Scottish jobs were ultimately supported by demand (largely from the off-shore extraction industry) for the sector's output. Demand from the rest of the UK, which is dominated by 'exports' of goods and services to the extraction industry in the North Sea, supported 36,612 Scottish jobs in 2014. These types of direct industry and supply chain jobs would continue to be relevant when and if the off-shore sector engages in geological carbon storage as well as oil and gas extraction.

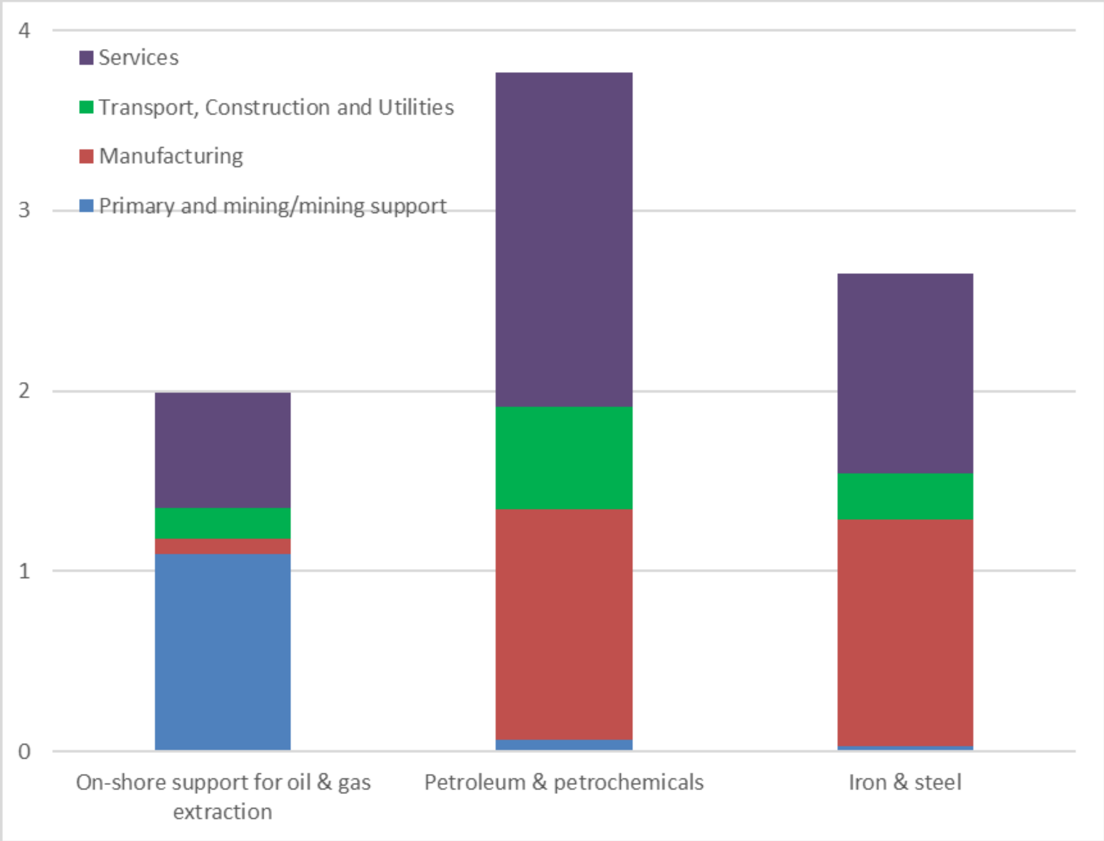
Turning to an example of a capture industry, in the case of 'petroleum and petrochemicals', £1.4bn of (largely export) demand supported 6,650 jobs, while the (also largely export) final demand of £250m for Scottish iron and steel production supported a total of 1,557 jobs across the wider economy. Other research that we have conducted in an international supply chain context (Turner *et al*., 2018c) demonstrates how multiplier analysis can be extended to consider the risks to the 'just transition' at home and abroad in terms of jobs offshoring/GDP loss and carbon leakage if decarbonisation of industries like this is not tacked at home. The Scottish multipliers developed here allow us to focus on the jobs and GDP side of this equation.

In Table 2, we introduce focus on another potential use of the Scottish multipliers. This is to generate cost or expenditure per job metrics. In the absence of defined scenarios to move to the type of 'cost per job' metric that could inform a CEA, we instead take an intermediate step by – as in Table 1 above – simply inverting the multiplier to state the outcome in terms of the implied expenditure required to generate each direct, indirect or induced job.

There are two key points to note in considering the multipliers in Table 2 and the type of jobs that CPJ metrics may be computed for.

First, the larger is the overall multiplier, the lower will be the implied expenditure (private and/or public) required to generate/support one job. Recognition of the indirect and induced jobs element reflects the importance of strong domestic supply chain development set out in the UK Industrial Strategy.

Figure 1. Key Scottish employment multipliers: FTE indirect and induced supply chain jobs grouped under four broad industry areas per direct industry FTE job



On the other hand, the second key point is that the two key potential industrial carbon capture sectors in Table 2 have lower overall multipliers but with a greater share accounted for by indirect and induced rather than direct jobs. This reflects the importance of quantifying multipliers in an economy-wide framework as indirect and induced jobs are often important but 'hidden' from direct policy attention.

Indirect and induced jobs are also important in the case of the 'onshore support for oil and gas extraction' sector. They account for half of the output-employment multiplier (Table 1) in the case of this industry, which is likely to play a key role in the transport and storage element of any CCUS system in Scotland. The magnitude of the jobs requirement in this sector is obviously important.

Moreover, as discussed for the wider UK economy in Turner *et al.* (2018a), the relationship between direct and indirect/induced jobs is also crucial important. Generally, CCUS-relevant sectors (both emitters, i.e. capture industries, and transport/storage providers) are likely to be capital-intensive with direct industry jobs thus being difficult to create in terms of the level of production activity required. But they are important sectors for domestic employment as the potential ripple effects throughout supply chains could be extensive if any industry activity were to relocate/off-shore if effective, efficient and competitive industrial decarbonisation strategies do not emerge.

For this reason, it is also useful to express the employment multiplier information from Table 2 in a different way. Figure 1 focuses on the number of FTE jobs supported per each direct industry job for each of our three example industries in turn. The bar for each industry indicates the breakdown of where supported jobs are located, here identifying four broad industry areas across the economy. This demonstrates the importance of CCUS sectors to sustaining jobs in other sectors, and in particular the services sectors and transport, construction and utilities.

Put another way, Figure 1 helps us to understand both the sectoral nature and the potential magnitude of the important indirect and induced impacts across the economy of job losses in any one sector. For example, the 'petroleum and petrochemicals' multiplier value in Figure 1 is 3.75. This implies that if even 20% of the 2014 direct FTE employment of almost two thousand were off-shored for reasons relating to decarbonisation costs/options, ultimately up to 1,500 Scottish jobs could be at risk. Around half of these are located in Scottish service sectors and about a third from an already shrinking Scottish manufacturing base.

On the other hand, both reporting variants of the employment multipliers also help us begin to think about the potential wider employment impacts if any CCUS-relevant sector were to grow as a result of a secure and reliable carbon capture, transport and geological storage network being established in Scotland.

Using output-employment multipliers of the type reported in Table 2 will permit a first estimate of the wider economic impacts of any pound growth in export and other demands for industry outputs. The variant in Figure 2 allows us to extrapolate from any additional jobs that may be announced to the total number of both direct industry and indirect/induced supply chain jobs that may be associated with such an industry expansion. We have proposed that the identification of a full range of indirect and induced jobs across different supply chain sectors allows us to assess not only the desirability of different types of job, but also base any 'cost per job' assessment associated with any required government support on a fuller consideration of cross-sectoral societal impacts.

4. Implications for further consideration of the potential value of CCUS to the political economy?

The type of multiplier work reported above for Scotland has already been reflected in what may be referred to as political economy narrative development for CCUS at the UK level. The work reported in Turner *et al*. (2018a) was reflected in one of the recommendations of the UK CCUS Cost Challenge Taskforce regarding the need to more fully assess the value of CCUS to the wider UK economy. In turn, the findings and language of the work is reflected in the UK Government Action Plan on CCUS, with citation within the following text:

> *"At a local and regional level, direct high value jobs in capital intensive industries, such as oil and gas, chemicals, and other energy intensive industries have been shown to support up to four jobs in indirect employment. Decarbonising these industries, potentially through deployment of CCUS, allows their* ***sustained contribution to economic growth*** *both nationally and in the regions in which the industry is concentrated. This is a key reason why CCUS is being progressed in other European industrial centres such as the Port of Rotterdam. Furthermore, skills and supply chains from the oil and gas and chemicals industries could transition to service a growing CCUS industry, allowing the* ***retention and creation of further high value jobs****."* (BEIS, 2018, p.29)

The language in this quote reflects the growing policy understanding of the importance of the type of industries and jobs that can be sustained and ultimately grow as a result deployment of CCUS. The outcomes that the multiplier metrics focus on are also key in the context of the type of return to public sector resources likely to be required in assessing public investment projects in **HM Treasury's 2019 Spending Review**, which, in turn will impact on the **CCUS Delivery and Investment Frameworks** to be considered in 2019 under the UK Government's CCUS Action Plan.

Thus, the real usefulness of the type of multiplier methods demonstrated here is in initial 'diagnosis' of what the **value case for CCUS** may be. Once this is broadly recognised and agreed among a wide range of policy stakeholders, any 'next step' consideration of the actual value that may emerge as a result of alternative CCUS strategies and roll-outs will ultimately require application of more sophisticated economy-wide modelling methods. Nonetheless, calculation of multipliers and associated metrics from the official input-output component of national accounts is an invaluable evidence base to aid consideration of the value already provided by CCUS-relevant sectors. Indeed, the type of work reported in the present study could be usefully extended in a fuller **value-chain analysis**, considering both up and downstream supply chain dependencies between Scottish industries that may be directly or indirectly impacted by CCUS infrastructure and capacity in the economy. It could also be extended in the type of **new national industry proposition** presented for CCUS in the Norwegian case (SINTEF, 2018).

On the other hand, the input-output multiplier framework is limited when it comes to simulating the outcomes of developments that are likely to have impacts on industry decisions, markets and prices. For this reason, the process of reframing and considering the value case for CCUS must ultimately involve R&D investment in more extensive and sophisticated economy-wide modelling and simulation capacity. In the case of Scotland, this is accompanied by the need to improve accounting for the off-shore oil and gas extraction industry, which is both an important driver of employment activity (and GDP creation) and a key player in any future provision of carbon transport and storage services.

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References

BEIS, 2018. 'The UK Carbon Capture Usage and Storage Deployment Pathway: an Action Plan' UK Department for Business, Energy and Industrial Strategy [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/759637/beis-ccus-action-plan.pdf.

CCUS Taskforce, 2018. 'Delivering Clean Growth: CCUS Cost Challenge Taskforce Report', UK Department for Business, Energy and Industrial Strategy [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727040/CCUS_Cost_Challenge_Taskforce_Report.pdf.

SINTEF, 2018. 'Industrial opportunities and employment prospects in large-scale CO2 management in Norway'. SINTEF [online]. Available at https://www.nho.no/contentassets/e41282b08ceb49f18b63d0f4cc9c5270/industrial-opportunities-ccs_english.pdf.

Turner, K. 2015. 'Preliminary Study on Developing Economic Multipliers for CO_2-EOR Activity: An initial examination of developing a multiplier for CO_2-EOR to examine and compare financial benefit'. Scottish Carbon Capture and Storage [online]. Available at: http://www.sccs.org.uk/expertise/reports/co2eor-joint-industry-project.

Turner, K., Race, J., Alabi, O., and Low, R., 2018a. 'Making the macroeconomic case for near term action on CCUS in the UK? The current state of economy-wide modelling evidence', *University of Strathclyde,* [online]. Available at: https://strathprints.strath.ac.uk/63554/.

Turner, K., Alabi, O., Smith, M., Irvine, J., and Dodds, P., 2018b. 'Framing policy on low emissions vehicles in terms of economic gains: Might the most straightforward gain be delivered by supply chain activity to support refuelling?', Energy Policy, [online] 119, pp.528-534. Available at: https://www.sciencedirect.com/science/article/pii/S0301421518303033?_rdoc=1&_fmt=high&_origin=gateway&_docanchor=&md5=b8429449ccfc9c30159a5f9aeaa92ffb.

Turner, K., Katris, A., de Vries, F. P., & Low, R., 2018c. 'The Just Transition Challenge: Avoiding Carbon Leakage and Jobs Off-Shoring in Decarbonising International Supply Chains', University of Strathclyde, [online]. Available at: https://strathprints.strath.ac.uk/66207/.

Turner, K., Alabi, O., Low, R. & Race, J. (2019) 'Reframing the Value Case for CCUS: Evidence on the Economic Value Case for CCUS in Scotland and the UK', Technical report available at https://doi.org/10.17868/67391.

United Nations Framework Convention on Climate Change [UNFCCC]. (2015). Paris agreement. Available at https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

ZEP, 2018. European Zero Emissions Platform (ZEP) report: 'Role of CCUS in a below 2 degrees scenario' [online].Available at: https://tinyurl.com/CCUSBelow2degrees.