Net Zero Teesside

Preliminary Environmental Information Report

Volume III - Appendices

Appendix 20A: Economic Benefits Report

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)

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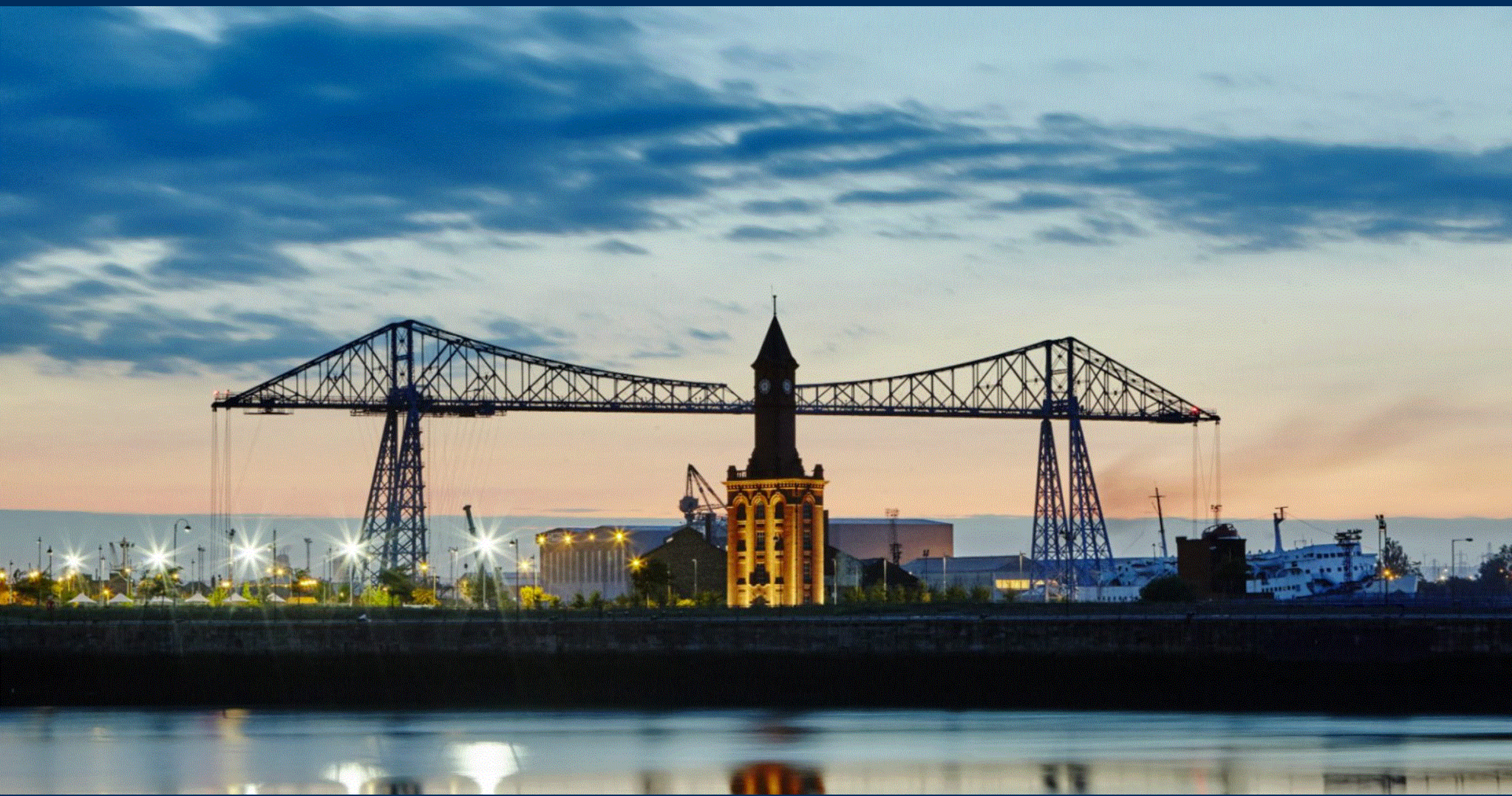
Prepared for: Net Zero Teesside Power Ltd. & Net Zero North Sea Storage Ltd.

Net Zero Teesside Economic Benefits



Report prepared for Net Zero Teesside

May 2020

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Executive summary

Net Zero Teesside offers the opportunity for a regeneration of Tees Valley and for the UK to take the first step in unlocking the long-term benefits of carbon capture, utilisation and storage. The Net Zero Teesside (NZT) project is an ambitious but credible pathway to achieve a decarbonised industrial cluster at Teesside capable of capturing and storing up to 10 Mtpa of CO_2 by 2030. This represents a major infrastructure investment for Teesside and the UK, and is a first step in unlocking the potential climate and economic benefits from carbon capture, utilisation and storage (CCUS).

Deploying CCUS at scale by 2030 is essential in order for the UK to meet its 2050 net zero emissions target. CCUS technologies are needed for firm low-carbon generation, to decarbonise existing industrial facilities, to produce low-carbon hydrogen for use in transport and for heat, and to generate negative emissions using bioenergy with carbon capture and storage (BECCS). Despite a false start during the last decade, the UK is again ready to start deploying commercial scale CCUS. Momentum for CCUS is accelerating, driven by increasing public concerns about climate change, the government's commitment to net zero emissions by 2050, and the announcement of £800m to support the development of CCUS in this year's budget (HM Treasury, 2020). NZT offers the opportunity to pioneer these essential technologies in a place with a rich industrial heritage and help the UK meet its ambitious climate commitments.

Direct benefits

NZT could generate substantial direct economic benefits for Teesside and the UK, including economic growth and employment. This study estimates that:

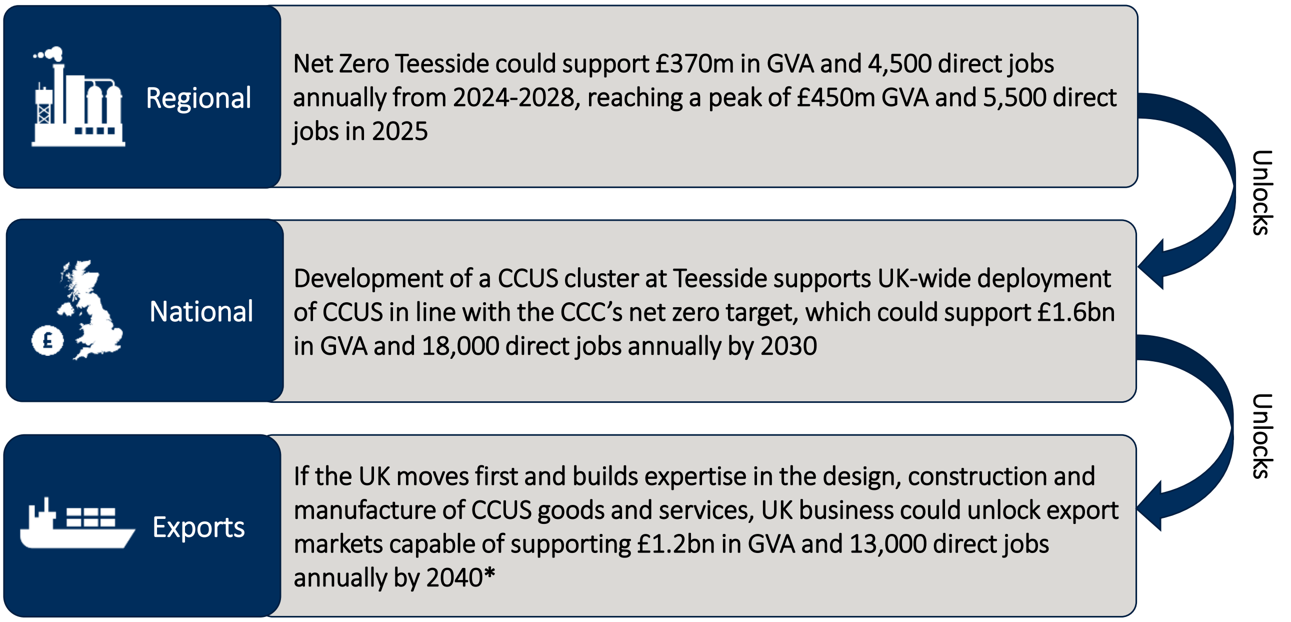
- NZT could support £4.8 billion in cumulative direct gross value added (GVA) (undiscounted) throughout the project lifetime.[1] During the construction phase, NZT could support £370 million in direct GVA and 4,500 direct jobs annually from 2024 to 2028, reaching a peak of £450 million in direct GVA and 5,500 direct jobs in 2025.

- NZT helps position UK firms to win CCUS contracts across the UK and internationally. National deployment of CCUS could support £1.6 billion in direct GVA and 18,000 direct jobs annually by 2030.

- The export of CCUS goods and services could support £1.2 billion in direct GVA and 13,000 direct jobs annually by 2040.[2]

[1] Gross value added (GVA) is the value of goods and services produced less the cost of all inputs and raw materials used in production.
[2] National deployment refers to deployment of CCUS throughout the UK. This includes deployment at Teesside and deployment beyond Teesside. Cumulatively, the level of national deployment modelled here is in line with the Committee on Climate Change's (CCC's) Further Ambition scenario from the net zero technical advice to government (CCC, 2019).

Figure 1 NZT direct benefits



Note: *Exports could support £1.1bn in GVA and 12,500 jobs by 2030
Source: Vivid Economics

The UK is likely to be a strong competitor in CCUS goods and services given existing strengths in engineering, construction management, and sector strengths in oil and gas and speciality chemicals. At Teesside, there is an existing supply chain potentially capable of supporting the build-out of CCUS, including multiple design houses, industrial gas and chemical facilities, catalyst manufacturing, and skilled tradespeople for construction and installation activities such as pipefitting and welding. Given these existing strengths, the direct benefits set out above rely on the assumption that the UK can supply content for CCUS projects at the same level as existing market shares in similar goods and services.

There is an opportunity for targeted supply chain interventions and higher levels of innovation spending to increase the level of UK content in CCUS projects and generate more direct benefits for the UK. Under this scenario, UK market share could be up to 20% higher in domestic and export markets. As a result, direct benefits could increase by £30 million in GVA and 500 jobs at NZT annually from 2024 to 2028. At the national level, these interventions could support a £300 million increase in GVA and an additional 5,000 jobs annually. Supplier and innovation support also mitigates difficult trade-offs between UK content levels and consumer costs by positioning UK suppliers as preferred suppliers for both cost and quality reasons.

However, without government and industry support, UK suppliers could lose out to international competitors, reducing the direct benefits from CCUS projects to the UK. This could reduce UK market share by 20% or more in the domestic and export markets. As a result, direct benefits from NZT could decline by £70 million in GVA and 1,000 jobs annually over 2024–28. At the national level, UK-captured GVA could decline by £600 million and employment by 5,000 annually.

Wider-economy benefits

NZT direct project spending will flow through the local and national economy, generating wider-economy benefits. This includes indirect economic growth and employment from business-to-business spending, and induced economic growth and employment from household-to-business spending—for example, indirect spending in the supply chain and induced spending on local services such as hotels and restaurants. During the construction phase, NZT could support £750 million in indirect and induced GVA and 13,500 indirect and induced jobs annually. Wider-economy benefits will continue during the operation phase, when NZT could support £600 million in indirect and induced GVA and up to 9,500 indirect and induced jobs annually.

The NZT CCUS system and low-carbon fuel production could enable and safeguard energy-intensive jobs. By offering access to a carbon capture system and low-carbon fuels, NZT can reduce carbon costs for local industry and allow industry to offer differentiated low-carbon products, which could ultimately fetch a premium on carbon-constrained international markets. These NZT-enabled low-carbon options support continued industrial activity at Teesside and could attract new firms looking to reduce carbon costs and produce low-carbon products. Continued industrial activity supports and safeguards existing energy-intensive jobs, while new investment could enable new ones. As a result, NZT could support and safeguard between 35% and 70% of existing manufacturing jobs in Tees Valley and help enable at least 7,000 potential jobs identified in the South Tees Development Corporation (STDC) master plan.

Opportunities to address labour and skills shortages and maximise local participation

The Tees Valley labour market is weaker than the national labour market with relatively high unemployment and economic inactivity; yet there are currently multiple job vacancies. This points to a skills gap between unemployed workers and the skills required by employers. This gap is likely to widen given projected demand for new and existing jobs from NZT and other employers in the region. The construction phase of NZT could widen the existing labour and skills gap in Teesside substantially when the project will demand a mix of high- and low-skilled workers. The gap during the operation phase could be smaller given the existing slack in the chemical and process labour market, and the announced and potential closures of power and industrial facilities in the region.

Upskilling and active recruitment will be essential in order to employ local workers during each phase of the NZT project. A higher level of participation in the project by local workers can be achieved by:

- Leveraging existing policy interventions.
- Partnering with local education providers to expand and upskill potential workers.
- Recruiting experienced and highly skilled workers from facilities that have closed, announced imminent closure, or could potentially close.
- Recruiting Teesside residents currently working elsewhere in the UK or abroad.

Recommendations to maximise economic benefits

1. The UK must deploy at least one CCUS cluster by 2030 in order to position the UK as a leader in CCUS and help UK firms capture and lock in a share of the global market for CCUS goods and services. Moving first will require support from government to ensure CCUS projects are built, as well as concerted action by industry to leverage existing strengths. Waiting another decade to deploy CCUS will reduce direct benefits from the domestic market and could lock UK firms out of export markets.
2. Government and industry could fund supply chain support, including supplier and innovation support, in order to improve the competitiveness of UK suppliers. Supply chain support that improves competitiveness helps mitigate potential trade-offs between UK content levels and consumer costs.
3. To maximise local participation in the project, NZT should consider undertaking targeted labour market interventions, such as upskilling programmes and targeted recruitment, in order to reduce the local labour and skills gap and help deliver the economic benefits from NZT to Tees Valley residents.

Contents

List of tables

List of figures

List of boxes

Acronyms

BECCS	Bioenergy with carbon capture and storage
CAPEX	Capital expenditure
CCC	Committee on Climate Change
CCGT	Combined-cycle gas turbine
CCS	Carbon capture and storage
CCUS	Carbon capture utilisation and storage
CfD	Contract for difference
DEVEX	Development expenditure
EITE	Emissions-intensive and trade-exposed
EPCm	Engineering, Procurement, Construction management
ETP	Energy Technology Perspectives
EU	European Union
FOAK	First-of-a-kind
GVA	Gross value added
IEA	International Energy Agency
IIM	Investment Impact Model
IT	Information technology
LQ	Location coefficient
M&R	Mitigation and remediation
MMV	Measuring, monitoring and verification
Mtpa	Million tonnes per annum
NACE	Nomenclature of Economic Activities
NOAK	nth-of-a-kind
NSAR	National Skills Academy for Rail
NZT	Net Zero Teesside
O&M	Operations and maintenance
OPEX	Operating expenditure
RD&D	Research, design, and development
RoW	Rest of the world
SAM	Social Accounting Matrix
SSV	Skills shortage vacancy
STDC	South Tees Development Corporation
STEM	Science, technology, engineering and mathematics

TUCA	Tunnelling and Underground Construction Agency
TVCA	Tees Valley Combined Authority
UK	United Kingdom
UTC	University Technical College

1 Introduction

Net Zero Teesside (NZT) is a Carbon Capture Utilisation and Storage (CCUS) project in the North East of England. NZT aims to create the UK's first decarbonised industrial cluster by capturing the carbon emissions from power and industrial facilities at Teesside and storing the captured carbon in the North Sea. In order to achieve this vision, NZT aims to build the world's first commercial natural-gas-fuelled carbon capture power plant. This power plant will serve as the anchor load of the carbon capture and storage (CCS) system and will be joined by industrial facilities in the region, including fertiliser, chemicals and hydrogen producers, that plan to build carbon capture technology and use the transport and storage network to permanently store their carbon emissions under the North Sea. NZT represents a major infrastructure investment that could transform Teesside and the UK.

The NZT project as set out in this report represents a credible pathway to achieve a decarbonised industrial cluster at Teesside by 2030. This project is ambitious, but in line with the UK's broader net zero emissions target. The NZT project, as envisioned here, includes building three new combined-cycle gas turbine (CCGT) trains with CCUS, retrofitting existing biomass and energy-from-waste facilities with CCUS, and retrofitting existing industrial facilities with CCUS. In total, this represents approximately 10 Mtpa of CCS at Teesside by 2030.

Tees Valley has suffered from the decline of heavy industries such as steel, coal and shipbuilding, but faces favourable prospects due to a dynamic business and institutional culture. The region has recently faced high unemployment and low levels of economic activity, with heavy industry like steel reducing activity and closing plants, including the iconic Redcar facility. This, in part, reflects a general loss of competitiveness in heavy manufacturing in the UK and the restructuring of the UK economy towards advanced manufacturing and services. Local labour market dynamics reflect this challenge of reskilling. Despite high unemployment from closures, businesses in the region frequently report a skills shortage.

However, the business community has continued to invest in both physical and human capital. For example, PD Ports has invested £120 million in the past seven years in state-of-the-art infrastructure to expand capacity and service quality, while also funding learning and skill-raising for young people in the region. On the institutional side, the creation of the South Teesside Development Corporation (STDC) in 2016, the first of its kind outside of London, has allowed for greater lobbying at the national level and more effective regional organisation.

With the goal of becoming the world's first zero carbon industrial cluster by 2030, NZT embodies the prospect for an economic, social and environmental regeneration of Tees Valley. Locally, building and operating NZT could support economic growth and high-quality jobs for decades to come. Access to the NZT CO_2 transport and storage network and low-carbon fuels could attract new investments in infrastructure and technology, revitalising the region. For Tees Valley residents, NZT could grant momentum in building local skills and increasing the qualifications rate of the workforce through specialised vocational training.

At a national level, NZT could be the leader in carbon capture and low-carbon industry. The skills and expertise built at Teesside could support wider development of CCUS across sectors (power, industry, hydrogen production) and throughout the UK. Compared with other low-carbon projects in the UK, NZT is more advanced in technical and feasibility stages. Accordingly, it is best placed to become the UK's first decarbonised industrial cluster.

The objective of this study is to identify the potential short- and long-term economic benefits from NZT and to assess the capacity of the national supply chain and the local labour market to ensure that these benefits are maximised for Teesside and the UK. This report is intended as an exploratory exercise to identify what is possible under an ambitious, yet credible, CCUS deployment scenario at Teesside, and does not represent specific commitments to UK content, employment levels or CCUS investments. The report is structured as follows:

- Section 2 estimates the potential direct economic benefits from CCUS at the NZT project level, the national level and from export markets;
- Section 3 estimates the potential wider economic benefits from NZT, including indirect and induced benefits and employment supported, safeguarded and enabled by NZT;
- Section 4 examines the impact of higher and lower levels of UK content on economic growth and employment;
- Section 5 assesses the Tees Valley labour market and skills availability in the region and explores interventions that could increase local participation in the NZT project; and
- Section 6 concludes.

Table 1 describes the types of benefits covered and the section in which they are assessed.

Table 1 Description of direct, indirect and induced benefits

Type	Definition	Section
Direct	Supported from project expenditure	2
Indirect	Supported from project spending in the supply chain	3.1
Induced	Supported from direct and indirect employee spending	3.1
Indirect-Enabled	Unlocked from the STDC master plan with low-carbon infrastructure and fuel	3.2
Indirect-Supported and Safeguarded	Existing direct jobs that are supported and safeguarded with-low carbon infrastructure and fuel	3.2

Source: Vivid Economics

2 Direct benefits

NZT could generate direct economic benefits for Teesside and the UK, including economic growth and employment. This study estimates that:

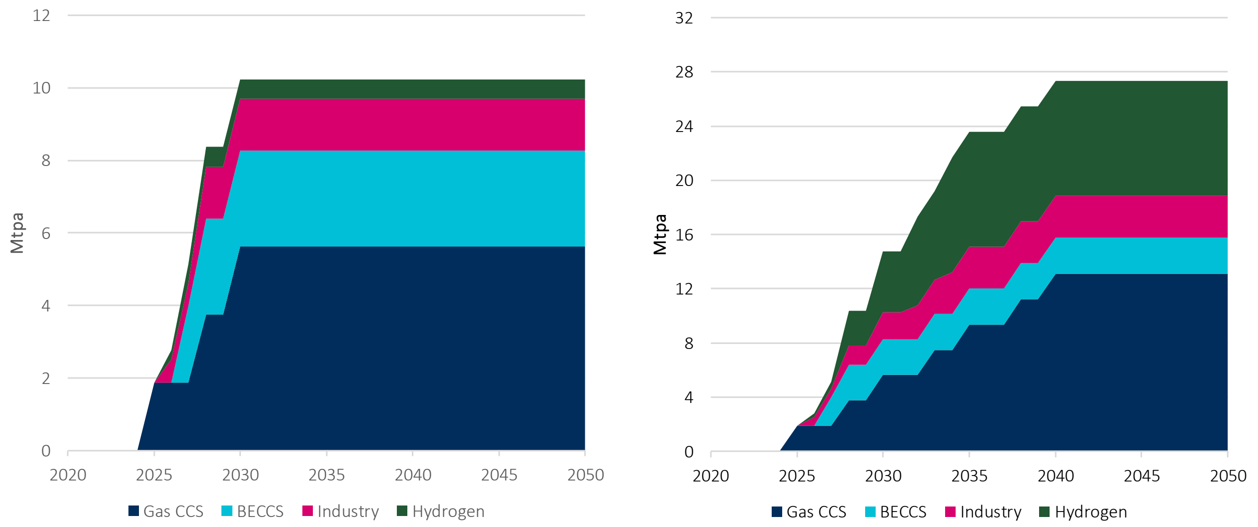
- NZT could support £370 million in gross valued added (GVA) and 4,500 direct jobs annually from 2024 to 2028, reaching a peak of £450 million in GVA and 5,500 direct jobs in 2025.
- UK-wide deployment could support £1.6 billion in GVA and 18,000 direct jobs annually by 2030.
- The export of CCUS goods and services could support £1.2 billion in GVA and 13,000 direct jobs annually by 2040.

Deploying CCUS in line with the Committee on Climate Change's **(CCC's) net zero advice will generate direct economic benefits for the UK, including economic growth and employment.** Economic benefits arise from expenditure on CCUS goods and services during the development, construction and operation of CCUS projects, which benefit UK suppliers with contracts and UK workers with employment. This section estimates the GVA UK firms could capture and the number of UK workers who could be employed through expenditure on CCUS goods and services in three markets: the NZT project; the UK domestic market; and the global export market. This section also assesses a more ambitious version of the NZT project, 'Teesside Future', where additional CCUS is deployed in the power, industry and hydrogen production sectors.[3]

Development of a CCUS cluster at Teesside supports UK-wide deployment of CCUS in line with the CCC's net zero target. The deployment levels set out below reflect a high level of ambition at Teesside and throughout the UK, including approximately 10 Mtpa of carbon capture by the NZT project by 2030 and 170 Mtpa of carbon capture by the entire UK by 2050. This level of UK-wide deployment is consistent with the CCC's Further Ambition scenario in the CCC's net zero advice to government (CCC, 2019). Figure 2 sets out CCUS deployment for each of the Teesside scenarios by sector. Figure 3 sets out UK CCUS deployment consistent with the CCC's net zero target by market and sector under the Further Ambition scenario. This includes deployment of CCUS in power (composed of gas CCUS and bioenergy with carbon capture and storage (BECCS)), industry and for hydrogen production. In order to estimate the direct benefits from export markets, this analysis assumes the EU27 and the rest of the world (RoW) markets deploy CCUS consistent with the CCUS deployment rates in the IEA'S Energy Technology Perspectives (ETP) 2-degree scenario (IEA, 2017).[4] Figure 4 sets out CCUS deployment in the EU27 and RoW export markets by market and sector.

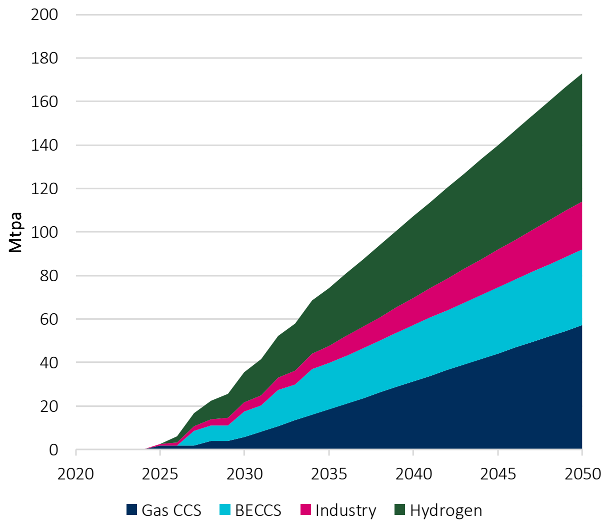
[3] Future hydrogen production in the Teesside Future scenario is in line with total UK hydrogen deployment and is based on a high-level assessment of potential regional demand that is consistent with rapid UK adoption of hydrogen in transport and heat in the North of England.
[4] Given low levels of CCUS deployment to date in export markets, this study assumes a five-year delay in obtaining the IEA's ETP CCUS 2050 deployment levels in export markets, within interim deployment (2020–25) based on the CCS Global Institute's 2019 annual report (Global CCS Institute, 2019).

Figure 2 Cumulative capture capacity by CCUS sector to 2050 (NZT left panel, Teesside Future right panel)



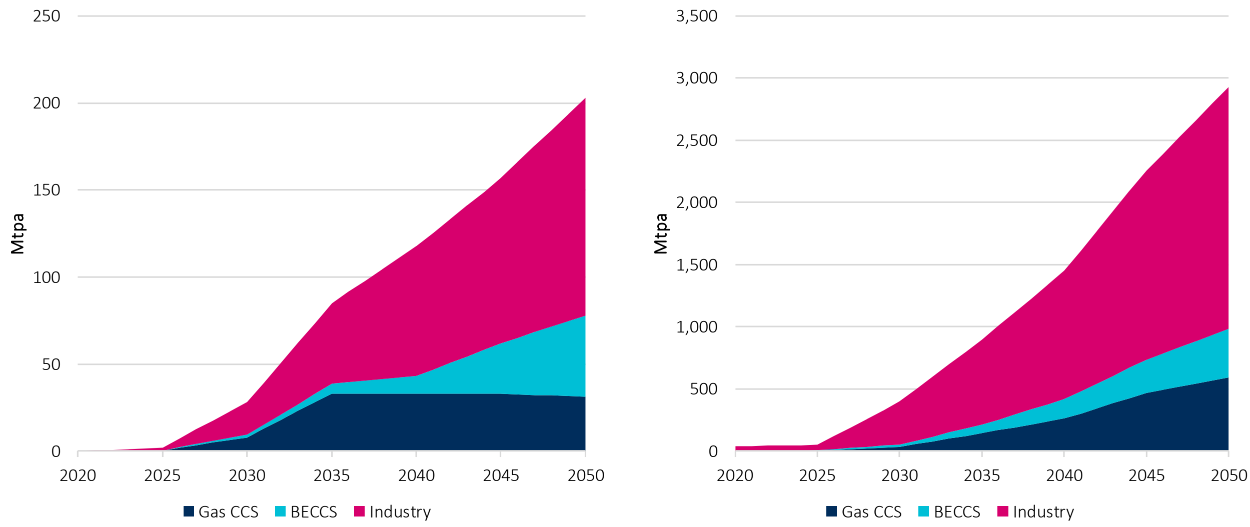
Source: Vivid Economics

Figure 3 Cumulative capture capacity by CCUS sector to 2050 (UK)



Source: Vivid Economics based on CCC (2019)

Figure 4 Cumulative capture capacity by CCUS sector to 2050 (EU27 left panel, RoW right panel)



Source: Vivid Economics based on IEA (2017) and Global CCS Institute (2019)

Direct economic benefits from CCUS depend on the quantity of CCUS deployed and the UK content of the goods and services purchased to deliver CCUS projects. The estimates below assume CCUS deployment consistent with the CCC's net zero target (Further Ambition scenario), which is set out above, and UK content levels consistent with the existing UK market share in similar goods and services today. Obtaining the same market share as similar goods and services today relies on the UK moving first by deploying CCUS clusters by 2030 and UK firms leveraging expertise in existing strengths such as oil and gas, chemicals and engineering. If the UK develops a domestic CCUS market first, then UK firms and workers can build expertise in the design, construction and manufacture of CCUS goods and services, allowing UK business to successfully compete for contracts in export markets. Given the uncertainty of future global deployment levels, only the domestic opportunities associated with hydrogen production with CCUS are considered. Table 2 sets out potential UK content levels by market based on the trade in similar goods and services (BEIS, 2019b and UN Comtrade). This level of UK content assumes positive support to industry from the UK deploying CCUS by 2030 and UK firms actively leveraging existing expertise in related industries.

Table 2 UK content by market

	UK market	EU27 market	RoW market
Services			
Development, EPCm, installation (Power, industry, transport & storage)	91.0%	5.5%	5.5%
Development, EPCm, installation (Hydrogen)	93.1%	4.9%	4.9%
Operations & maintenance	95.0%	N/A - Low tradability	N/A - Low tradability
Goods			
Power (new build)	19.9%	2.1%	0.6%
Industry and power (retrofits)	56.4%	5.9%	1.8%
Transport & storage	24.0%	4.7%	1.5%
Hydrogen	41.2%	Not assessed	Not assessed

Note: EPCm, Engineering, Procurement, Construction management.
Source: Vivid Economics based on UN Comtrade

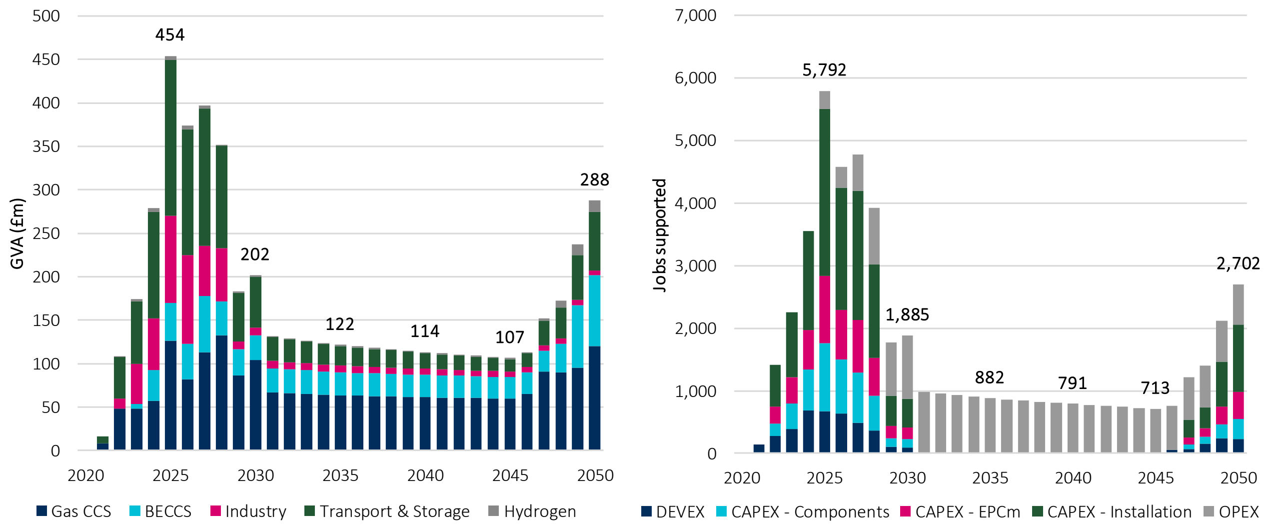
The cost of deploying CCUS consistent with the CCC's net zero target is likely to change over time, reflecting learning rates and the cost difference between new build and retrofits. This assessment assumes that unit costs decline over time in order to reflect the cost savings from moving from first-of-a-kind (FOAK) to nth-of-a-kind (NOAK) CCUS projects. Expenditure levels also reflect the substantial cost difference between retrofits and new build projects. CCUS retrofits of gas generation in the UK are unlikely to be economic given required development times and existing asset lifetimes. However, most existing UK biomass capacity is new enough to retrofit, which is further supported by Drax's proposal to retrofit its biomass capacity with CCUS (Zero Carbon Humber, 2019). Accordingly, for the domestic market, this assessment assumes that there are no CCUS retrofits of gas generation, but that all biomass generation that began operating after 2010 is retrofitted with CCUS before new BECCS capacity is built. For the export analysis, this assessment assumes no retrofits, given IEA ETP deployment profiles.

Direct employment benefits estimate the number of jobs supported by CCUS expenditure. Job estimates are the number of full-time equivalents supported directly through CCUS expenditure. These are direct jobs 'supported', not jobs 'created', since the workers directly supported by CCUS expenditure may be attracted to or displaced from other sectors due to changes in energy consumption and investment.

2.1 Net Zero Teesside

During the construction phase, NZT could support £370 million in GVA and 4,500 direct jobs annually from 2024 to 2028. GVA and job benefits are greatest during the peak of construction activity, supporting £450 million in GVA and 5,500 direct jobs in 2025. Benefits are driven by the deployment of 10 Mtpa of CCUS at Teesside by 2030. This includes deploying 2.1 GW of gas CCUS, retrofitting the equivalent of 0.4 GW of BECCS (including some energy-from-waste retrofits) and capturing 1.4 Mtpa from existing industries. During the operation phase (2030–50), NZT could support £120 million in GVA and 900 jobs annually. Throughout the lifetime of the project (2020–50), NZT could support £4.8 billion in cumulative GVA (undiscounted). Figure 5 sets out GVA by CCUS sector and employment by expenditure.

Figure 5 NZT GVA and employment benefits to 2050 (GVA left panel, jobs right panel)

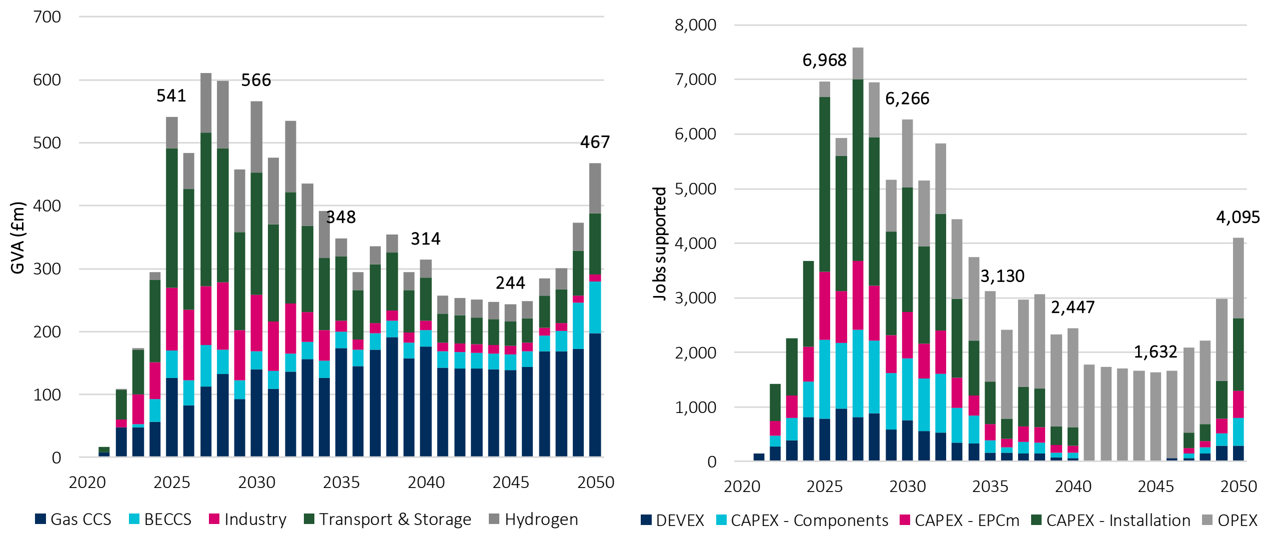


Note: DEVEX, development expenditure; CAPEX, capital expenditure; OPEX, operating expenditure.
Source: Vivid Economics

2.2 Teesside Future

'Teesside Future' could support £500 million in GVA and 5,500 jobs annually, on average, from 2025 to 2035. Teesside Future benefits peak two years after NZT benefits as it continues to add power, industry and hydrogen production with CCUS, which supports additional GVA and employment through the 2030s. GVA and employment benefits peak in 2027, reaching £600 million in GVA and 7,500 jobs. Benefits are driven by the deployment of 27.3 Mtpa of CCUS by 2040, including 5.3 GW of CCUS power and capturing 3.1 Mtpa from industry. Compared with NZT, this includes four additional gas CCGT trains (0.7 GW each), an additional 1.6 Mtpa of industry CCUS, and an additional 4 GW of hydrogen production with CCUS. The additional industry capture assumes that nearly all existing carbon-intensive industry in Tees Valley deploys CCUS with a 90% capture rate. Figure 6 presents GVA by CCUS sector and employment by expenditure.

Figure 6 Teesside Future GVA and employment benefits to 2050 (GVA left panel, jobs right panel)

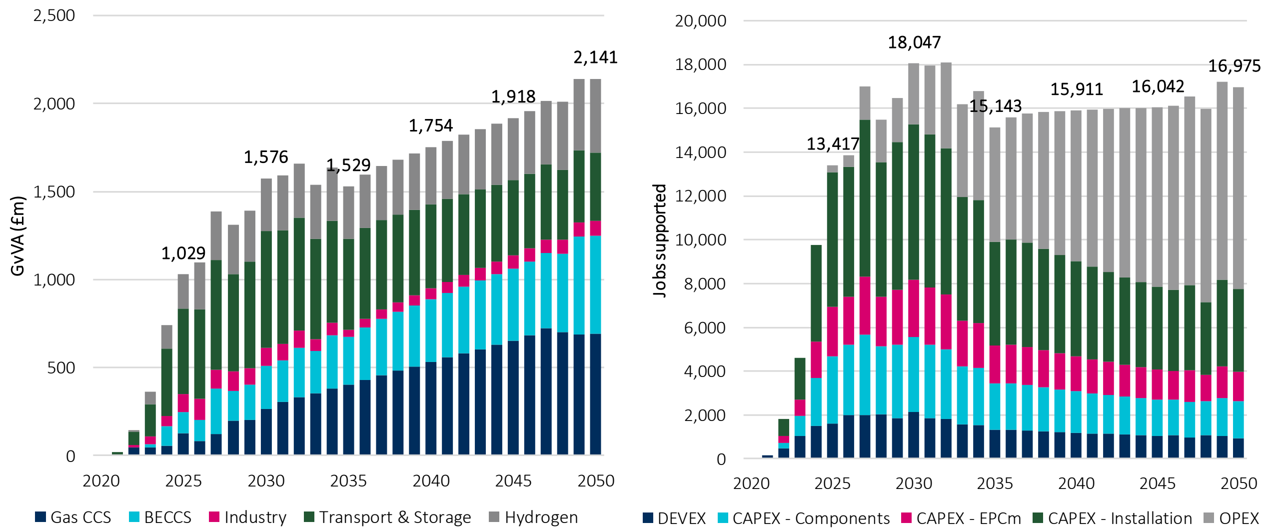


Source: Vivid Economics

2.3 Domestic market

At the national level, deployment of CCUS in line with the CCC's net zero advice could support £1.6 billion in GVA and 18,000 jobs annually by 2030. By 2050, the CCUS industry could support £2.1 billion in GVA and 17,000 jobs annually. The minor decline in employment from 2030 to 2050 reflects the transition of employment from the construction phase to the operation phase for most CCUS facilities. These benefits are driven by the UK deploying 173 Mtpa of CCUS by 2050, which includes 26 GW of CCUS power (composed of gas CCUS and BECCS), capturing 22 Mtpa from industry and deploying around 30 GW of hydrogen production with CCUS. Figure 7 shows GVA by CCUS sector and employment by expenditure for the UK to 2050.

Figure 7 Domestic market GVA and employment benefits to 2050 (GVA left panel, jobs right panel)



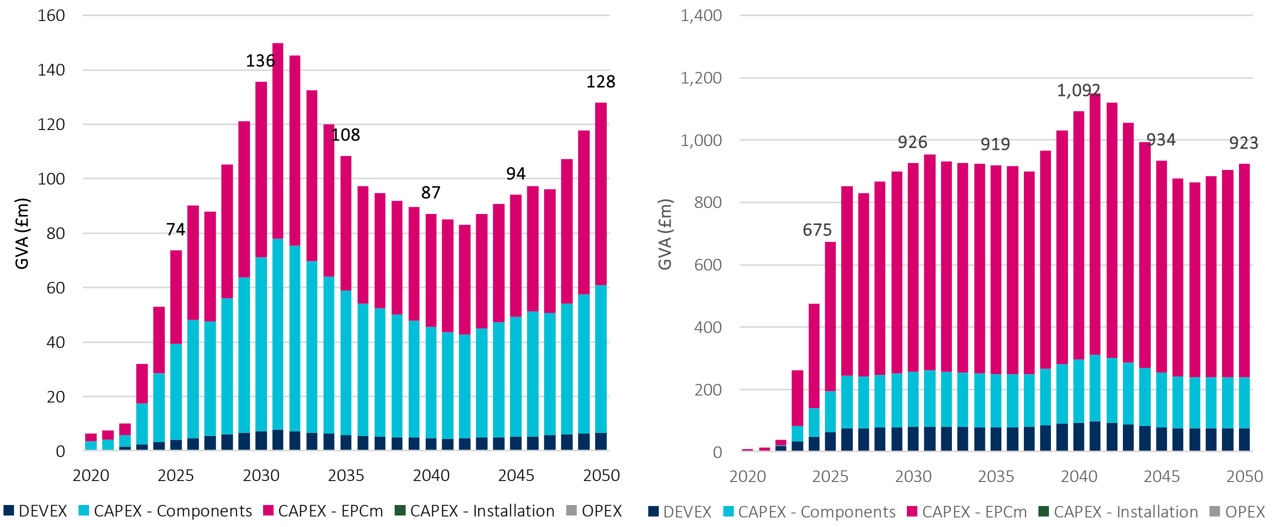
Source: Vivid Economics

2.4 Export market

By 2040, UK business could unlock export markets capable of supporting £1.2 billion in GVA and 13,000 direct jobs annually from the sale of CCUS goods and services. The UK could capture up to £130 million GVA annually in 2030 and 2050 from exports to the EU27, and over £900 million in GVA annually from 2030 to 2050 from exports to the RoW. Exports to the EU27 support around 1,500 jobs in 2030 and 2050 while exports to the RoW support substantially more jobs, with 11,000 in 2030 and 12,000 in 2040. The greatest benefits are generated from the export of services, such as engineering, to the RoW market. This reflects the size of the RoW market for CCUS goods and services, which, under the IEA ETP 2-degree scenario, could reach 2,930 Mtpa by 2050. This includes the deployment of 222 GW of CCUS power (composed of gas CCUS and BECCS) and capturing 1,950 Mtpa from industry by 2050.[5] Figure 8 presents GVA from exports by CCUS sector to 2050.

[5] Direct benefits from coal CCUS generation are not considered in this report. Given the lack of domestic deployment, the UK is unlikely to be competitive in the global market for coal CCUS goods and services.

Figure 8 Export market GVA benefits to 2050 (EU27 left panel, RoW right panel)

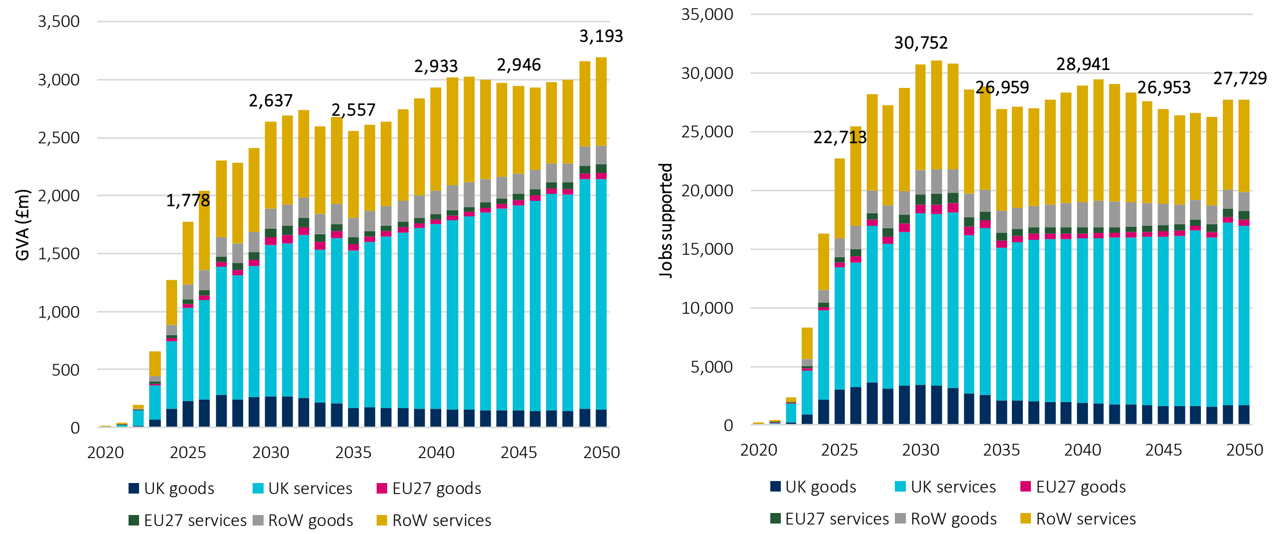


Source: Vivid Economics

2.5 Total direct benefits

In total, the domestic and export markets could support more than £2.6 billion in GVA and more than 25,000 jobs annually from 2030 to 2050. Demand for UK services in the domestic market, including engineering, installation and operation of CCUS facilities, generates the largest share of direct benefits. Demand for UK services in export markets, specifically for EPCm services, generates the second largest share of direct benefits. Figure 9 presents GVA and employment by type of expenditure and market.

Figure 9 Total GVA and employment benefits to 2050 (GVA left panel, jobs right panel)



Source: Vivid Economics

2.6 CO_2 import potential

In a decarbonising world, the North Sea's carbon storage potential could facilitate the import of CO_2 to the UK for permanent storage, unlocking business opportunities for UK firms and workers. Deploying CCUS and then shipping CO_2 to the UK could offer a solution for European countries without storage potential or where there is low public acceptability of CCUS, such as Germany (European Commission, n.d.). In Europe, there are few countries with long-term storage potential, with the British, Dutch and Norwegian sectors of the North Sea offering the greatest storage potential.[6] In terms of potential volumes, the Global CCS Institute estimates that the North Sea has 200 Gt of CO_2 storage potential, which could support the 2050 UK CCUS volumes (173 Mtpa) for centuries (Global CCS Institute, 2019). However, this is likely to be a long-term opportunity given the current immaturity of the CCUS sector and the distance between EU industrial facilities and potential offshore storage locations.

The UK is unlikely to be the first European country to import CO_2 and store it in the North Sea, but could be one of the largest importers by mid-century. The Netherlands could be best placed to store imported CO_2 first, given its proximity and interconnectedness with the heavily industrialised German Rhineland and the industrial regions of Belgium, including the refineries and chemical facilities in Antwerp. By the late 2030s or 2040s, a larger storage market could develop, with the UK and Norway also competing for CO_2 imports. By this date, Norway will have likely deployed the necessary CCUS to meet domestic climate objectives but could face barriers from the remoteness of storage facilities. The Northern Lights project, which is currently awaiting final investment decision, could be a first test of Norwegian CO_2 import potential (Equinor, 2020). UK facilities could benefit from greater accessibility, including existing offshore oil and gas facilities with the potential to be repurposed for CO_2 storage. However, until mid-century, the UK is expected to continue building out domestic CCUS facilities and could face supply chain constraints to build out addition CO_2 import infrastructure.

Indicative estimates suggest that the market for CO_2 imports could reach billions of pounds annually by mid-century. For example, North Rhine Westphalia, the German state encompassing the Rhine-Ruhr industrial region, emits 54 Mt of CO_2 annually (LANUV, n.d.). By 2050, assuming the same level of industrial emissions and applying a 2050 carbon price less the cost of CO_2 transport and storage, there is potentially a £10.8 billion to £12 billion market to import and store the emissions from this industrial region (BEIS, 2019b).[7] Further analysis is needed to fully size the European and global opportunity for the UK to import and permanently store CO_2 in the North Sea.

[6] An estimated 50% of European CO_2 storage potential is located under the North Sea (Element Energy 2010).
[7] 2050 carbon price adjusted to 2017£ less the cost of CO_2 transport and storage. For 2050 carbon prices, see DECC (2011).

3 Wider-economy benefits

NZT project spending will flow through the local and national economy, generating wider-economy benefits. This includes indirect economic growth and employment from business-to-business spending and induced economic growth and employment from household-to-business spending. During the construction phase, NZT could support £750 million in indirect and induced GVA and 13,500 indirect and induced jobs annually. Wider-economy benefits will continue during the operation phase, when NZT could support £600 million in indirect and induced GVA and 9,500 indirect and induced jobs annually.

The NZT CCUS system and low-carbon fuel production can support, safeguard and enable energy-intensive jobs at Teesside. By offering access to a carbon capture system and low-carbon fuels, NZT can support and safeguard existing energy-intensive jobs and enable new energy-intensive jobs by reducing carbon costs and increasing international competitiveness with low-carbon product offerings. As a result, NZT could support and safeguard between 35% and 70% of existing manufacturing jobs in Tees Valley and help enable at least 7,000 potential jobs identified in the STDC master plan.

Direct NZT project expenditure will generate wider-economy benefits in the supply chain and local economy, while the NZT CCUS system and low-carbon fuel production can support, safeguard and enable energy intensive jobs. This section estimates the wider-economy benefits of NZT. These include the indirect economic impacts from NZT project spending in the supply chain and the induced economic impacts from workers spending their wages. This section also considers the wider-employment benefits from access to the NZT carbon capture network and low-carbon fuels. Access to these low-carbon technology options can support and safeguard existing energy-intensive jobs and enable new energy-intensive jobs targeted in the STDC master plan. Table 3 sets out the classification of these benefits and their relationship to direct NZT project expenditures. The direct benefits from NZT are set out in Section 2.

Table 3 Classification of economic benefits

Type	Definition	Section
Direct	Supported from project expenditure	2
Indirect	Supported from project spending in the supply chain	3.1
Induced	Supported from direct and indirect employee spending	3.1
Indirect-Enabled	Unlocked from the STDC master plan with low-carbon infrastructure and fuel	3.2
Indirect-Supported and Safeguarded	Existing direct jobs that are supported and safeguarded with-low carbon infrastructure and fuel	3.2

Source: Vivid Economics

3.1 Indirect and induced benefits

Direct project expenditures continue to flow through the economy after the initial transaction for CCUS goods and services, generating indirect and induced economic benefits. Indirect economic benefits are generated from project spending in the supply chain and refer to secondary business-to-business transactions. For NZT, the indirect economic benefits are the contracts for goods and services that NZT suppliers offer their suppliers for intermediate inputs. Induced economic benefits are generated by workers employed directly and indirectly by NZT spending their wages in the local economy. Induced economic benefits are household-to-business transactions. For NZT, the induced economic benefits include expenditure in the North East by workers on a variety of goods and services such as food and drink, consumer durables and entertainment. Indirect and induced economic benefits are estimating using Vivid's Investment Impact Model (IIM).

Box 1 Vivid's Investment Impact Model (IIM)

Vivid's input–output IIM is best-suited to assess the impact of the NZT project on the regional and national economy. An input–output model captures interactions and feedback loops between all sectors in an economy, and allows for the calculation of the indirect and induced impacts (in terms of GVA and jobs) alongside the direct impact.[8]

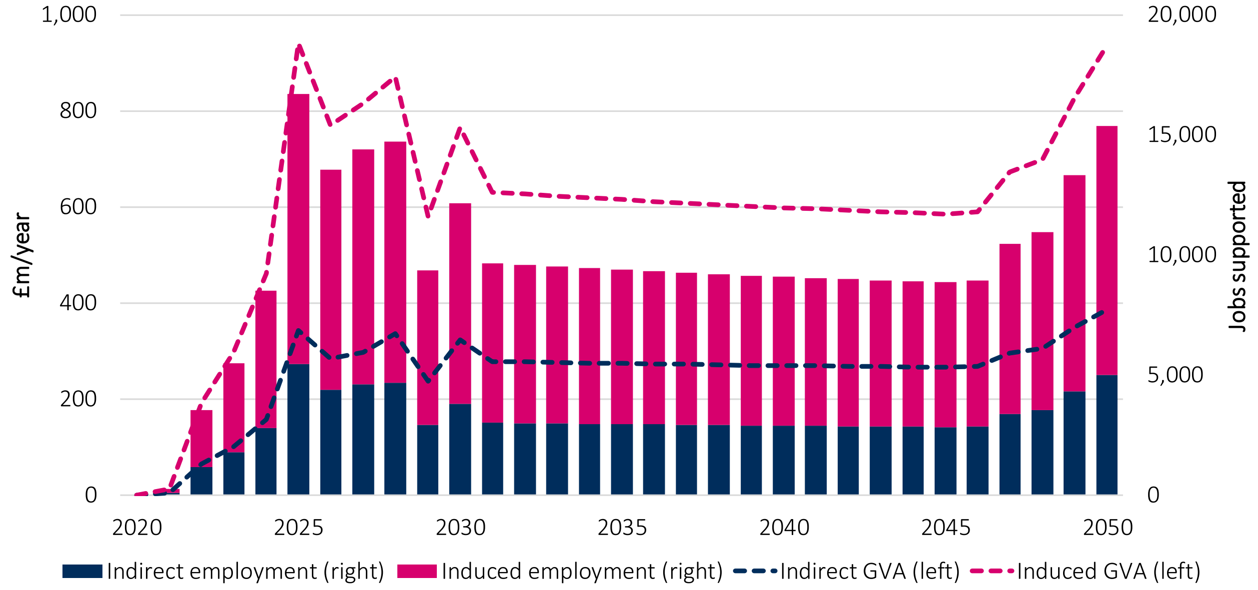
The IIM is tried and tested in this task. It has been used successfully for Tees Valley Combined Authority (TVCA), informing its short- and long-term policy development strategies and selection of appropriate investments. It was essential that TVCA had a robust understanding of the scale of impact (and potential for displacement) of the proposed Freeport on the STDC site to ensure that the incentive package offered was not overly generous, and thereby safeguarding a net return to the region. The model has been updated and fully calibrated to the UK and the North East.

During the construction phase, NZT could support £750 million in indirect and induced GVA and 13,500 indirect and induced jobs annually. The largest indirect and induced benefits occur during the construction phase. This includes approximately £250 million in indirect GVA and £500 million in induced GVA generated annually from the flow of expenditure throughout the North East economy. Construction expenditure supports approximately 4,500 indirect jobs and 9,000 induced jobs.

During the operation phase, NZT could support £600 million in indirect and induced GVA and 9,500 indirect and induced jobs annually. This includes approximately £250 million in indirect GVA and £350m in induced GVA generated annually from the flow of operational expenditure throughout the economy. Operational expenditure supports 3,000 indirect jobs and 6,500 induced jobs. Figure 10 sets out the indirect and induced economic impacts throughout the lifetime of the NZT project.

[8] Direct benefits are benefits that directly result from investment in a sector. Indirect benefits refer to additional benefits in sectors supplying to the investment sector, while induced benefits refer to additional economic benefits from household spending.

Figure 10 NZT indirect and induced economic impacts



Source: Vivid Economics

3.2 Supported and safeguarded and enabled jobs

Supported and safeguarded and enabled jobs are identified as jobs and potential jobs in emissions-intensive and trade-exposed (EITE) sectors of the economy.[9] These jobs are at risk of being moved abroad if the sectors they are part of are not internationally competitive. Constructing the NZT CO_2 transport and storage network and the related availability of low-carbon fuel mitigates the cost of carbon emissions for industry and could increase international competitiveness through the production of 'differentiated' low-carbon products (e.g. low-carbon chemicals). These products could at some point fetch a premium on carbon-constrained global markets or from climate-conscious businesses and consumers. This results in supporting and safeguarding existing energy-intensive jobs and enabling potential energy-intensive jobs identified by the STDC master plan.

NZT could support and safeguard between 35% and 70% of existing manufacturing jobs in Tees Valley. Construction of NZT could facilitate the introduction of carbon capture and/or the use of low-carbon fuels, such as hydrogen, at energy-intensive industrial facilities in Tees Valley. Adopting either of these low-carbon technologies would allow existing industrial facilities to reduce their carbon emissions, thereby reducing their carbon costs. Low-carbon production also enables the manufacture of low-carbon products, which are differentiated from existing products and may command a premium, increasing the international competitiveness of firms in the region. Table 4 sets out the range of existing jobs that could be supported and safeguarded by NZT. The low range includes only EITE jobs, while the high range includes jobs in sectors with close economic linkages.

[9] The Technical Annex sets out how these EITE jobs are identified.

Table 4 NZT supported and safeguarded jobs

Sector	Low	High
Chemicals and chemical products	3,155	3,550
Basic metals	1,675	1,855
Food products	1,740	4,275
Other mining and quarrying	550	580
Coke and refined petroleum	410	410
Extraction of crude petroleum and natural gas	300	305
Fabricated metal products (ex. machinery and equipment)	110	3,450
Other EITE production	250	1,835
Total	**8,190**	**16,260**
Share of existing manufacturing jobs	**35.3%**	**70.0%**
Share of existing total jobs	**3.2%**	**6.3%**

Source: Vivid Economics based on ONS (2018) and European Commission (2019)

NZT could enable at least 7,000 potential jobs identified in the STDC master plan, increasing manufacturing jobs in Tees Valley by 30%.[10] These are the EITE jobs identified by the STDC master plan, which could be enabled by NZT due to the accessibility of a CCS network and low-carbon fuels. This is a conservative estimate. These jobs are derived directly from the STDC master plan and exclude multiple other brownfield sites in Tees Valley, which could benefit from access to the CCUS network and low-carbon fuels. Table 5 sets out the distribution of NZT enabled jobs.

Table 5 NZT enabled jobs

Sector (Location)	Activities	Enabled jobs
Port-based fabrication 1 (South Industrial Zone)	Port-based fabrication, port-based fabrication (no berth), port support operations, undersea cable, steel foundation casting (offshore)	3,640
Port-based fabrication 2 (South Industrial Zone)	Steel making from scrap, contract fabrication, contract fabrication (heavy components), fabrication support, contract stamping	2,330
Salvage and metal processing logistics Innovation (South Industrial Zone)	Scrap terminal, scrap processing, sorting & storage, landfill reserve	650
Energy Innovation (North Industrial Zone)	Lithium ion battery recycling and manufacturing	550
Total*		**7,170**
Increase in manufacturing jobs		**+30.9%**
Increase in total jobs		**+2.8%**

Source: Vivid Economics based on STDC (2019)

[10] The STDC master plan targets the creation of 20,000 net new jobs.

4 Supply chain scenarios

The UK is likely to be a strong competitor in CCUS goods and services given existing strengths in engineering and construction management, and sector strengths in oil and gas and speciality chemicals. Accordingly, the direct benefits rely on the assumption that the UK can supply content for CCUS projects at the same level as existing content levels in similar goods and services.

There is an opportunity for targeted supply chain interventions and higher levels of innovation spending to increase the level of UK content in CCUS projects and generate more direct benefits for the UK. Under this scenario, UK market share could be 20% higher in the domestic and export markets. As a result, direct benefits could increase by £30 million in GVA and 500 jobs at NZT annually from 2024 to 2028. At the national level, these interventions could support a £300 million increase in GVA and an additional 5,000 jobs annually.

However, without government and industry support, UK suppliers could lose out to international competitors, reducing the direct benefits to the UK from CCUS projects. This could reduce UK market share by 20% or more in the domestic and export markets. As a result, direct benefits from NZT could decline by £70 million in GVA and 1,000 jobs annually from 2024 to 2028. At the national level, UK-captured GVA could decline by £600 million and employment by 5,000 annually.

The UK has a number of supply chain strengths that make it a stronger competitor in CCUS goods and services. UK suppliers are competitive in specialist services, such as engineering, installation and construction management, chemicals, CCUS-related capture technology, CCUS research, design and development (RD&D) activities and, despite lacking a major power turbine manufacturer, balance of plant components. At Teesside, there is an existing supply chain potentially capable of supporting the build-out of CCUS, including multiple design houses, industrial gas and chemical facilities, hydrogen production facilities, catalyst manufacturing, steel pipe fabrication facilities and skilled tradespeople for construction and installation activities such as pipefitting and welding.

The direct benefits section assumes UK content levels for CCUS goods and services are consistent with the existing UK market share in similar goods and services today. This assumption relies on UK firms leveraging expertise in existing strengths such as oil and gas, chemicals and engineering to win contracts, and the UK deploying CCUS clusters by 2030. Early deployment of domestic CCUS facilities is essential in order to allow UK firms and workers to build expertise in the design, construction and manufacture of CCUS goods and services, which will help position UK suppliers to successfully compete for contracts in export markets. This is the central scenario.

Targeted supply chain interventions could further increase supply chain competitiveness and allow UK firms and workers to supply a higher level of UK content for CCUS projects, increasing the direct benefits to the UK. In order to understand what the UK stands to gain from targeted supply chain interventions, this section presents a 'high' direct benefits scenario, where higher levels of UK content in the domestic and export markets generate additional GVA and jobs for UK firms and workers. To allow for comparison with the central scenario, deployment levels and costs are held constant. This is a simplifying assumption. If the UK becomes more competitive in CCUS goods and services then this could lead to cost reductions and additional deployment of CCUS, generating consumer benefits and additional jobs and GVA.

However, without support from government and industry, UK suppliers could lose contracts to competitors, resulting in lower levels of UK content in CCUS projects at home and abroad, reducing the direct benefits to the UK. In order to understand what the UK stands to lose, this section also presents a 'low' direct benefits scenario where lower levels of UK content in the domestic and export markets reduce the GVA and employment benefits for UK firms and workers. To allow for comparison with the high and central scenario, deployment levels and costs are also held constant in this scenario. As with the high scenario, this is a simplifying assumption. If the UK becomes less competitive, then it is very likely that CCUS deployment levels would decline, resulting in an even larger decline in direct benefits. Consumer costs could also rise. Accordingly, this scenario is not designed to estimate a lower bound of direct benefits, but as an indicative measure of the costs of delay and inaction.

4.1 High scenario

The high scenario assumes that targeted supply chain interventions and high innovation spending increase UK competitiveness, increasing UK market share by 20%. This sensitivity test reflects a level of ambition consistent with the UK content target in the Offshore Wind Sector Deal (HM Government, 2019). Supply chain interventions for suppliers of existing goods and services increase operational efficiency and improve component quality, thereby increasing supply chain competitiveness. This applies to expenditure on:

- conversion and generation components, such as balance of plant components;
- CO_2 transport components, such as steel pipes; and
- gas reforming, such as industrial heat equipment.

Higher levels of RD&D spending by suppliers of immature CCUS goods and services generate innovative products and solutions, making UK suppliers preferred suppliers in the CCUS marketplace. This applies to expenditure on:

- EPCm services, such as engineering;
- capture components, such as solvents;
- storage components, such as compressors; and
- measuring, monitoring and verification (MMV)/mitigation and remediation (M&R) equipment, such as oceanography instruments.

The combination of supply chain interventions and high innovation increases UK market share by 20% for most components. Targeted interventions for suppliers of conversion and generation components lift the share of UK content from 0% to 15%, driven by higher levels of UK content in balance of plant. For export markets, trade data confirms this is achievable as UK content levels near competitor shares, but do not exceed them. This level of ambition (20% increase from baseline) is comparable to the content target in the Offshore Wind Sector Deal target (HM Government, 2019). Table 6 presents UK content levels for the high scenario.

Table 6 High scenario UK content by market

	UK market	EU27 market	RoW market
Services			
Development, EPCm, installation (Power, industry, transport & storage)	95.2%	6.6%	6.6%
Development, EPCm, installation (Hydrogen)	95.8%	5.9%	5.9%
Operations & maintenance	95.0%	N/A - Low tradability	N/A - Low tradability
Goods			
Power (new build)	33.6%	3.3%	1.8%
Industry and power (retrofits)	67.7%	7.0%	2.2%
Transport & storage	28.8%	5.6%	1.8%
Hydrogen	49.4%	Not assessed	Not assessed

Source: Vivid Economics based on UN Comtrade

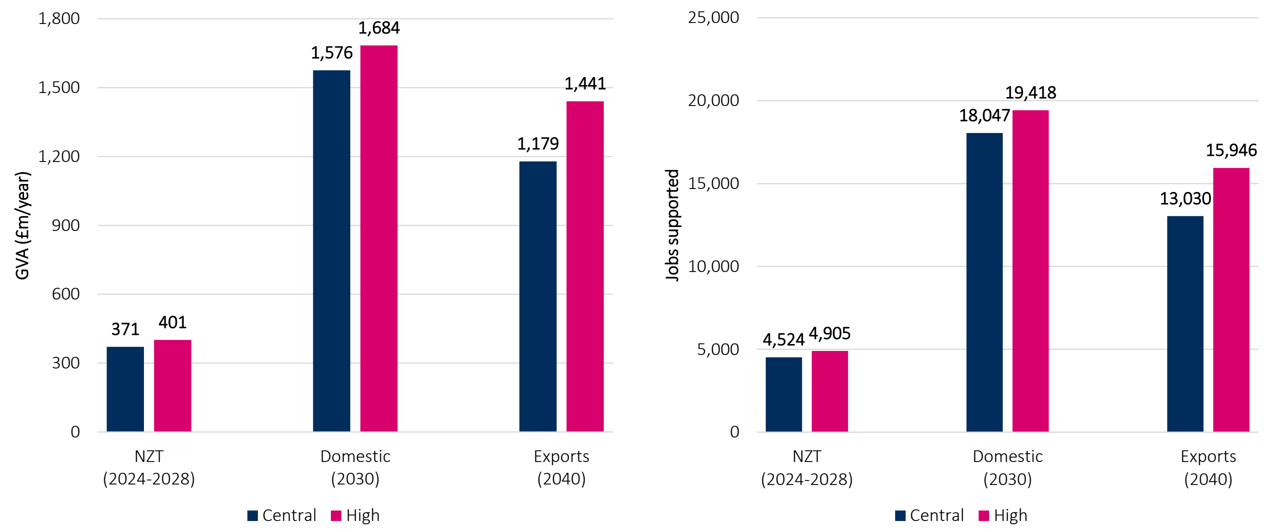
The high scenario supports £400 million in GVA and 5,000 direct jobs annually at NZT from 2024 to 2028. GVA and job benefits at the peak of construction reach £500 million in GVA and more than 6,000 direct jobs. This is an increase of £30 million in GVA and 500 jobs annually at NZT from 2024 to2028 compared with the central scenario. The increase is driven by UK firms capturing a larger share of the EPCm contracts and manufacturing a larger share of components, including capture and pollution control, and conversion and generation components.

Nationally, the high scenario supports an additional £100 million in GVA and 1,000 jobs annually throughout the 2030s. The modest increase from the central scenario reflects high levels of UK content in CCUS installation and operations and maintenance (O&M) activities in the central scenario as a result of the low tradability of these services. In 2050, under the high scenario, the CCUS industry could support £2.2 billion in GVA and 18,000 jobs annually.

In the high scenario, UK business unlocks export markets capable of supporting £1.4 billion in GVA and 16,000 direct jobs annually from the sale of CCUS goods and services in 2040. Compared with the central scenario, this is an additional £200 million in GVA and 3,000 jobs annually. This increase is driven by UK firms capturing a larger share of EPCm contracts in the EU27 and RoW markets, with additional capture in the RoW market providing the largest boost to UK GVA and employment.

In total, the domestic and export markets could support more than £3 billion in GVA and more than 30,000 jobs annually from 2030 to 2050. This is a £300 million increase in GVA and a 5,000 job increase from the central scenario. Figure 11 shows what UK firms and workers stand to gain from the high scenario for each market.

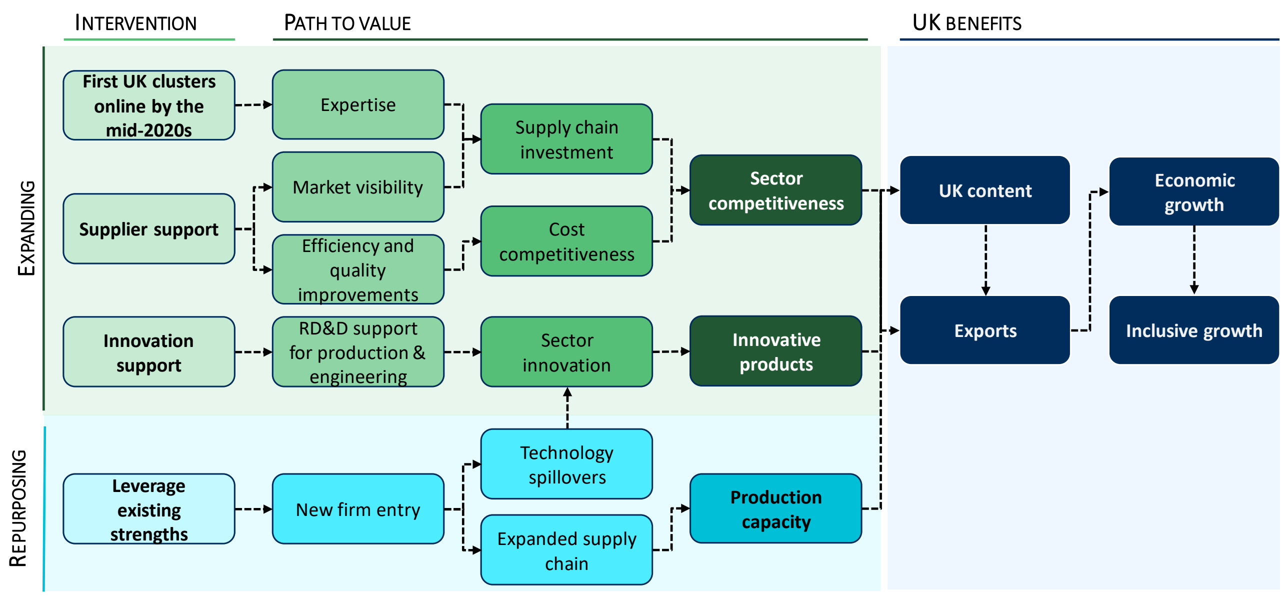
Figure 11 High scenario direct benefits (GVA left panel, jobs right panel)



Source: Vivid Economics

Delivering the higher levels of UK content set out in this scenario relies on supplier support and innovation support in combination with the UK moving first and leveraging existing strengths to maximise UK benefits from CCUS. Figure 12 sets out how the combination of these interventions can generate additional benefits for Teesside and the UK.

Figure 12 High scenario theory of change



Source: Vivid Economics

4.2 Low scenario

The low scenario assumes contracts are awarded to international suppliers and there is low innovation, reducing UK market share by 20%. This sensitivity test mirrors the assumed increase in the high scenario. The UK supply chain fails to win contracts as contracts for existing goods and services are awarded to international suppliers. This negatively impacts suppliers of:

- conversion and generation components;
- CO_2 transport components; and
- gas reforming.

Future contracts for new CCUS goods and services do not materialise as UK suppliers fail to undertake the necessary RD&D expenditure to offer innovative solutions and compete for contracts. This negatively impacts suppliers of:

- EPCm services;
- capture components;
- storage components; and
- MMV/M&R equipment.

The combination of lost contracts and low innovation reduces UK market share by 20% across all components and markets. This 20% decrease mirrors the magnitude of the increase from the high scenario to facilitate comparison. UK content in services with low tradability, including installation and O&M services, also declines as CCUS projects struggle to fill construction and operations roles and rely on international subcontractors where possible. This is not a 'worst-case scenario' for UK content, but a 'low' scenario as UK content levels could be substantially lower if international competitors overtake UK suppliers. Table 7 sets out UK content levels for the low scenario.

Table 7 Low scenario UK content by market

	UK market	EU27 market	RoW market
Services			
Development, EPCm, Installation (Power, industry, transport & storage)	72.1%	4.4%	4.4%
Development, EPCm, installation (Hydrogen)	73.5%	3.9%	3.9%
Operations & maintenance	76.0%	N/A - Low tradability	N/A - Low tradability
Goods			
Power (new build)	15.9%	1.7%	0.5%
Industry and power (retrofits)	45.1%	4.7%	1.5%
Transport & storage	19.2%	3.7%	1.2%
Hydrogen	33.0%	Not assessed	Not assessed

Source: Vivid Economics based on UN Comtrade

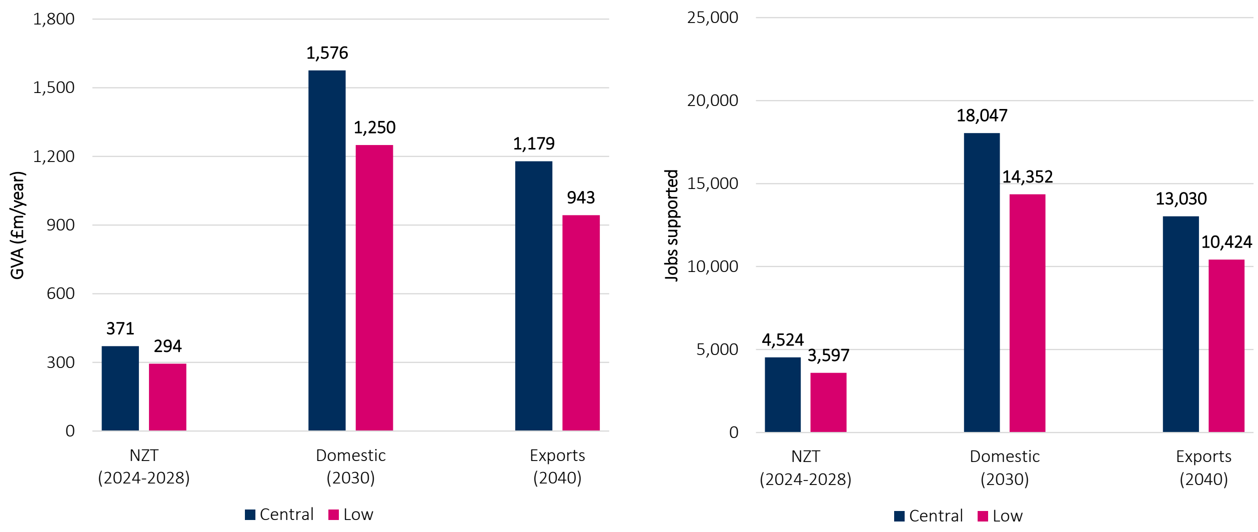
The low scenario estimates that NZT could support £300 million in GVA and 3,500 direct jobs annually from 2024 to 2028. GVA and job benefits at the peak of construction reach £370 million in GVA and more than 4,500 direct jobs. This is a decrease of £70 million in GVA and 1,000 jobs annually at NZT from 2024 to 2028 compared with the central scenario. The decline is driven by UK firms capturing a smaller share of the EPCm, installation and manufacturing contracts, with the loss of EPCm and installation contracts resulting in the largest decline.

Nationally, the low scenario reduces GVA by £350 million annually and employment by nearly 4,000. This decline from the central scenario reflects lower levels of UK content across CCUS projects, with the largest decline in GVA and employment in EPCm, installation and O&M services.

In the low scenario, UK businesses are less competitive in international markets, with exports supporting £900 million in GVA and 10,000 jobs annually. Compared with the central scenario, this is a reduction of £200 million in GVA and 3,000 jobs annually. The decline in exports of goods and services to the RoW market accounts for the largest share of the decline.

In total, under the low scenario, the domestic and export markets support £2 billion in GVA and around 20,000 jobs annually from 2030 to 2050. This is a £600 million decline in GVA annually, and a 5,000 job decline from the central scenario. Figure 13 presents what UK firms and workers stand to lose in the low scenario for each market.

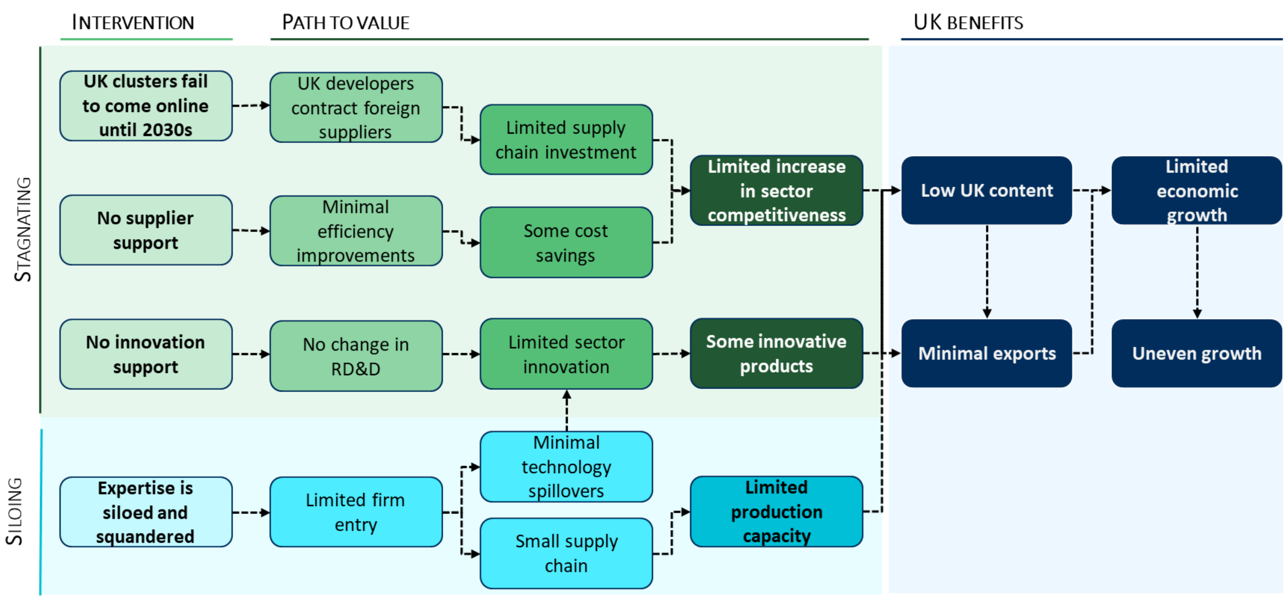
Figure 13 Low scenario direct benefits (GVA left panel, jobs right panel)



Source: Vivid Economics

In the low scenario, limited supplier support and low innovation spending combine with a prolonged deployment pathway and siloed expertise to limited direct benefits from CCUS. Figure 14 sets out how these missed opportunities negatively impact the potential direct benefits UK firms and workers can capture.

Figure 14 Low scenario theory of change



Source: Vivid Economics

4.3 Discussion

Targeting high UK content levels could entail trade-offs between securing UK benefits from CCUS, technical specifications and consumer costs. If contracts are awarded to UK suppliers only on the basis of increasing UK content levels, this could result in either lower technical standards or higher consumer costs—or both. The objective of high innovation and supply chain support is to make UK suppliers preferred suppliers for cost and quality reasons, therefore avoiding trade-offs between UK content and quality and consumer objectives. Deploying CCUS clusters in the UK first and funding innovation and supplier support is likely to result in higher costs in the short term with the aim of reducing costs and capturing a greater share of benefits in the medium and long term. However, the 'pay-off' of lower costs and more direct benefits in the future is uncertain and, given this uncertainty, moving first and funding innovation and supplier support carries risk.

Contractual enforcement of UK content reporting is an effective tool for measuring and targeting UK content levels. The lack of a major UK CCUS facility necessitated a top-down estimation of likely UK content in the NZT project. Supply Chain Plans supporting contract for difference bids for existing technologies, such as offshore wind, often use a bottom-up approach where total UK content is based on individual supplier estimates. Offshore wind developers rely on 'Contractual Enforcement of UK Content Methodology' to obtain supplier estimates. Adopting this for the NZT project could support the gathering of UK content-benchmarking data in the UK's first gas CCUS power station and decarbonised industrial cluster. This data could support the development of UK content targets for future CCUS projects.

Box 2 Best-practice case study: Offshore Wind Growth Partnership

The Offshore Wind Sector Deal targets increasing UK content in offshore wind projects from around 50% today to 60% by 2030. To achieve this goal and support UK suppliers, the offshore wind industry launched the Offshore Wind Growth Partnership, an initiative funded by £250m in industry commitments which is designed to:

1. Promote greater collaboration
2. Increase business competitiveness
3. Support innovation
4. Attract new entrants and growing existing companies

The Partnership is complemented by additional UK supply chain commitments including:

1. An independent supply chain review
2. Government £115m Strength in Places Fund
3. Local Enterprise Partnerships

(HM Government, 2019)

5 Labour supply and skills assessment

The Tees Valley labour market is weaker than the national labour market, with relatively high unemployment and economic inactivity; yet there are currently multiple job vacancies. This points to a skills gap between unemployed workers and the skills required by employers. This gap is likely to widen given projected demand for new and existing jobs from NZT and other employers in the region. The construction phase of NZT could widen the existing labour and skills gap in Teesside substantially when the project will demand a mix of high- and low-skilled workers. The gap during the operation phase could be smaller given the existing slack in the chemical and process labour market, and the announced and potential closures of large power and industrial facilities in the region.

Upskilling and actively recruiting workers will be essential in order to increase local participation during each phase of the NZT project. A higher level of participation in the project by local workers can be achieved by:

- Leveraging existing policy interventions
- Partnering with local education providers to expand and upskill potential workers
- Recruiting experienced and highly skilled workers from facilities that have closed, announced imminent closure, or could potentially close
- Recruiting Teesside residents currently working elsewhere in the UK or abroad

This section examines the labour supply and skills available in Tees Valley and assesses where gaps between labour and skills availability and demand from the NZT project are likely to occur. Best-practice interventions are identified in order to close these potential gaps. To complement this assessment, relevant labour and skills interventions from other large infrastructure projects are identified and discussed as case studies. This section is intended to gather evidence on the characteristics of the existing workforce in Teesside and investigate the type of interventions that could strengthen it. It does not set out the steps to create an exclusive Teesside-only workforce, but rather presents potential options on how to ensure that local labour has the opportunity to participate in the project.

5.1 Labour and skills availability

There are 273,000 jobs in Tees Valley across a range of industries, with a large number in the Chemical and Process sector. The share of employment in chemical and process and raw materials and agriculture (which includes bioscience) sectors is greater than the national average. However, there is likely to be substantial slack in the chemical and process labour market given the 35% decline in jobs over the last five years, which compares with a 9% increase nationally. Table 8 sets outs the Tees Valley jobs profile by sector.

Table 8 Tees Valley employment by industry

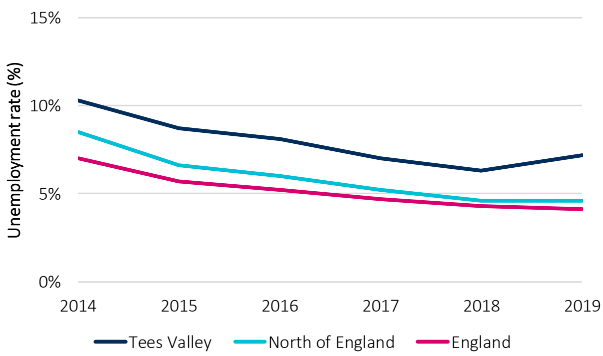
Industry Sector	Tees Valley Jobs (2018)	Change (2013-2018)	% Change (2013-2018)	% Change Nationally (2013-2018)	Location Quotient
Chemical and Process	5,361	-2,822	-35%	9%	2.2
Raw Materials and Agriculture	6,255	-275	-4%	7%	1.8
Advanced Manufacturing	18,055	3,235	22%	8%	1.5
Clean Energy Low Carbon	8,215	1,327	19%	13%	1.4
Healthcare	35,978	-4,143	-10%	10%	1.3
Other Public Services	49,386	1,355	3%	2%	1.1
Other Private Services	38,786	-643	-2%	4%	1.1
Logistics	19,399	4,022	26%	10%	1.0
Construction	12,844	-1,058	-8%	20%	0.9
Other Manufacturing	9,742	1,861	24%	7%	0.9
Creative, Culture and Leisure	30,228	804	3%	12%	0.8
Professional and Business Services	32,238	4,792	18%	14%	0.7
Digital	6,455	1,415	28%	27%	0.7
Biologics	143	-68	-32%	3%	0.2

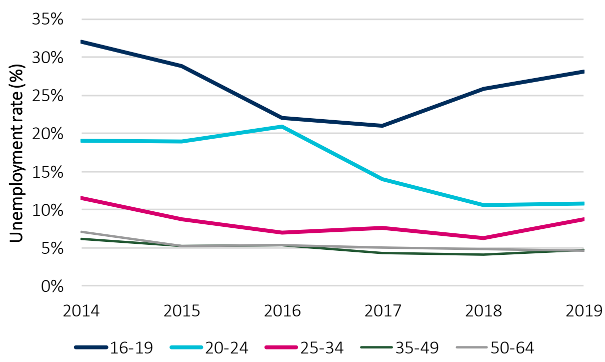
Note: The location quotient measures the concentration of jobs. Location quotients greater than 1 indicate a higher concentration of jobs in an industry sector than the national average.

Source: TVCA (2020) based on Emsi

The Tees Valley labour market is weaker than the national labour market, with relatively high unemployment and economic inactivity. Unemployment in Tees Valley is 75% higher than the national average, at 7.2% in 2019. Unemployment in Tees Valley disproportionately affects the under-24 age group, with over a quarter (28%) of 16–19-year-olds and 11% of 20–24-year-olds unemployed, compared with 17%, and 10% nationally. Tees Valley also has a higher share of economically inactive people (26%) than the national average (21%). The economically inactive population includes those outside the labour force—the long-term sick, students and retired people, for example. Graduate underemployment is also high, but in line with the national average (~25%). Figure 15 compares the Tees Valley unemployment rate with that of the North and England overall, and sets out the unemployment rate in Tees Valley by age group.

Figure 15 Unemployment rates by location (left panel) and by age group in Tees Valley (right panel)





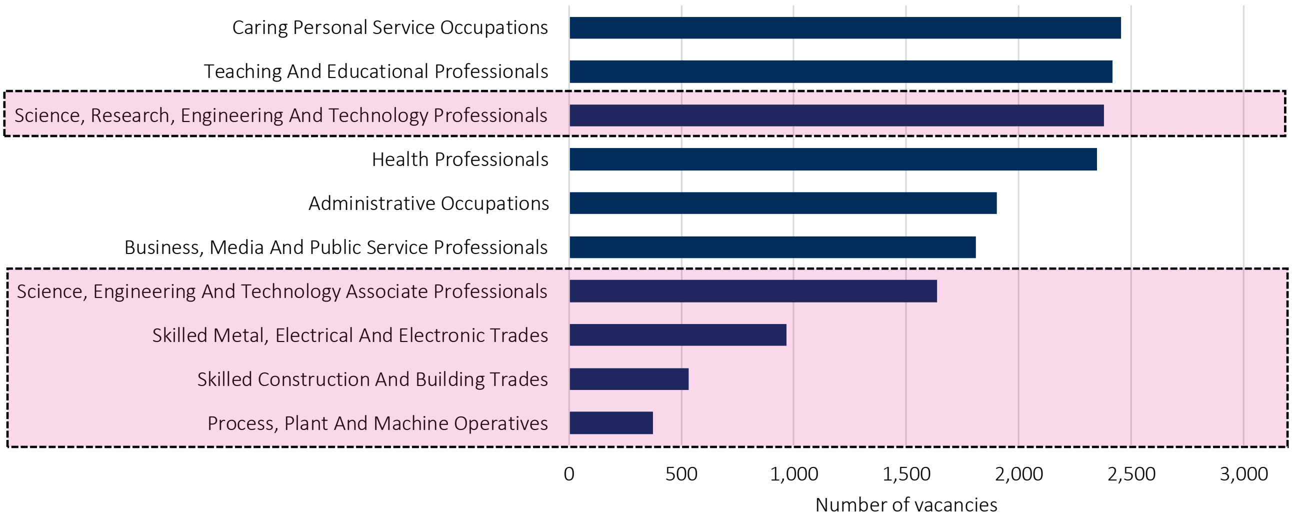
Source: TVCA (2020) based on ONS APS (2019)

Interview evidence suggests that a number of highly skilled Tees Valley residents are likely employed elsewhere and could potentially be attracted back into the local labour market. These residents are likely concentrated in the oil and gas, chemicals, construction and engineering sectors and may be interested in working in Teesside full time for the right wage and employment opportunity.

Throughout 2019, there were 27,500 job vacancies advertised online in Tees Valley, equivalent to 10% of existing jobs. Many of these vacancies are for jobs similar to those NZT will demand during the construction or operation phase. Relevant to the construction phase, during 2019 there were 1,000 vacancies for Skilled Metal, Electrical and Electronic Trades and 500 vacancies for Skilled Construction and Building Trades.

Relevant to the operations phase, during 2019 there were 2,400 vacancies for Science, Research, Engineering and Technology Professionals, 1,600 vacancies for Science, Engineering and Technology Associate Professionals, and 375 vacancies for Process, Plant and Machine Operatives. Figure 16 sets out the number of vacancies throughout 2019 by occupation.

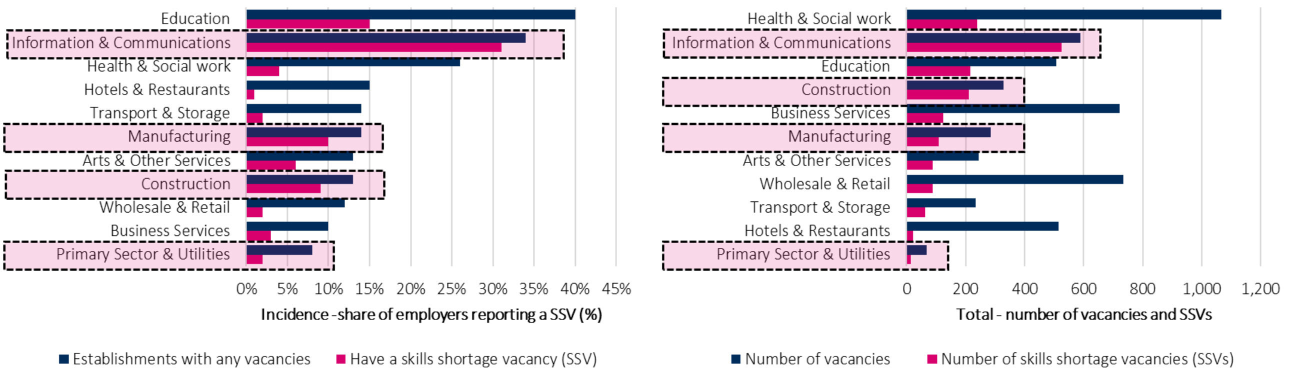
Figure 16 Tees Valley job vacancies throughout 2019 by occupation



Source: TVCA (2020) based on Burning Glass Labour Insight

High levels of unemployment and economic inactivity, despite existing vacancies, suggest a skills mismatch in the Tees Valley labour market. Employers reporting skills shortages in Tees Valley confirm this, with skills in IT, Construction, Education and Manufacturing most in demand. Of all vacancies in Tees Valley, 27% are classified as skills shortage vacancies (SSVs), which compares with 22% nationally. However, Tees Valley is converging to the national average as the number of its SSVs has declined by 11 percentage points since 2013, compared with a national increase of 1 percentage point. Figure 17 presents the share of employers reporting SSVs and the share of SSVs by type.

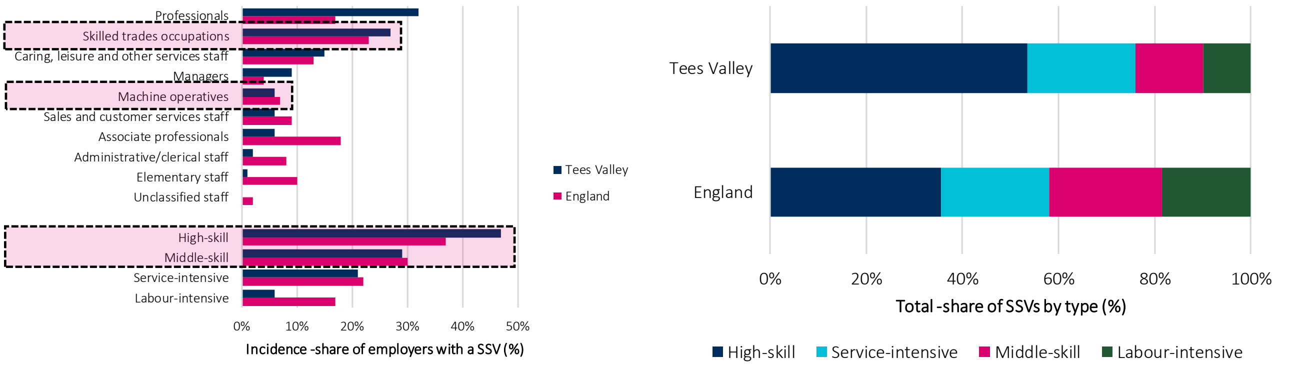
Figure 17 Share of employers with a skills shortage vacancy (left panel) and share of vacancies which are skills shortage vacancies (right panel)



Source: Department for Education (2018)

Tees Valley employers are more likely to report an SSV for high-skilled occupations and Tees Valley has a higher share of high-skill SSVs than the rest of the country. Relevant for NZT, Tees Valley has a greater number of employers reporting SSVs for skilled trades occupations than the rest of the country. However, the supply of high-skill operations workers could increase by 2025 if announced industrial facility closures and potential power station closures take place. Figure 18 sets out employers reporting an SSV by occupation and compares the distribution of SSVs to the national distribution.

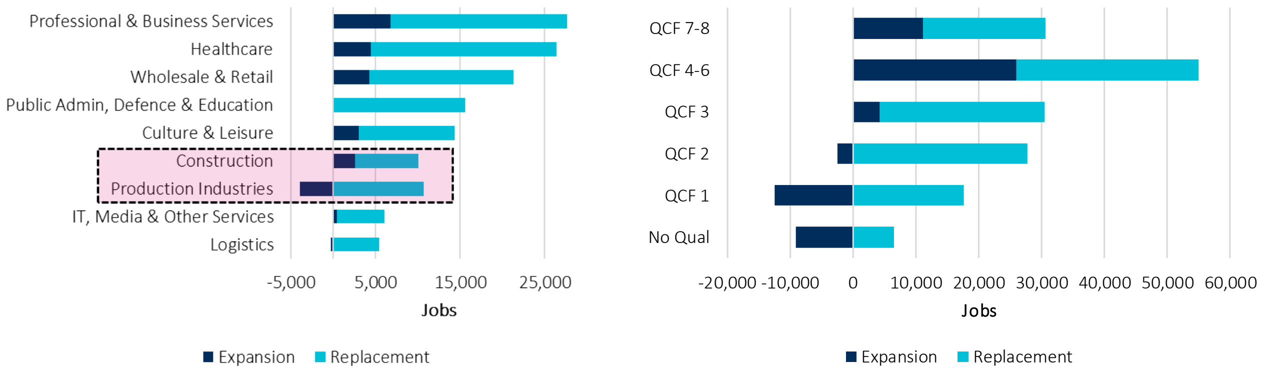
Figure 18 Share of employers reporting a skills shortage vacancy by occupation (left panel) and share of skills shortage vacancies by skill level and location (right panel)



Source: Department for Education (2018)

In addition to existing vacancies, Working Futures projects Tees Valley will need to fill 133,000 jobs between 2014 and 2024. This includes 17,000 new jobs and 116,000 replacement jobs, but excludes the 20,000 net new jobs targeted by the STDC. Working Futures also projects a decline in production industry jobs and low-skilled jobs. Figure 19 sets out these Working Futures projections.

Figure 19 Projected job demand in Tees Valley to 2024 by sector (left panel) and projected job demand in Tees Valley to 2024 by skill level (right panel)

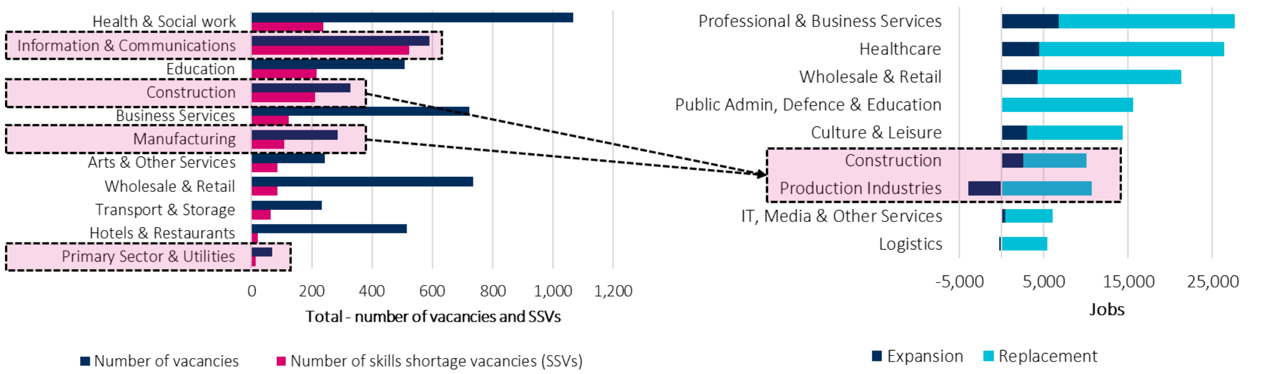


Source: TVCA (2020) based on Working Futures

NZT will demand a mix of high- and low-skilled workers during the construction and operations phases, with demand for labour peaking during the construction phase. The construction phase of NZT will demand a variety of high- and low-skilled construction and installation workers and a variety of support roles, but the overwhelming demand will be for skilled trades occupations. The operation phase will demand skilled trades occupations and process, plant and machine operatives. Jobs enabled by NZT will be predominately demand manufacturing and fabrication labour, as will STDC-targeted jobs.

There is an existing labour gap in the construction sector that is likely to widen in the future, and a smaller labour gap for O&M and manufacturing activities. Demand from NZT is likely to widen the existing labour gap in Teesside, with the largest gap likely to be for construction labour during the construction phase. The gap during the operational phase of NZT is likely to be smaller given the projected decline in demand for production industry jobs, the potential closure of the Hartlepool nuclear power station (EDF estimates generation to end in 2024), the announced closure of the INEOS Seal Sands facility, and the existing slack in the chemical and process labour market.[11] Figure 20 identifies the likely labour supply gaps.

Figure 20 Labour supply gap analysis



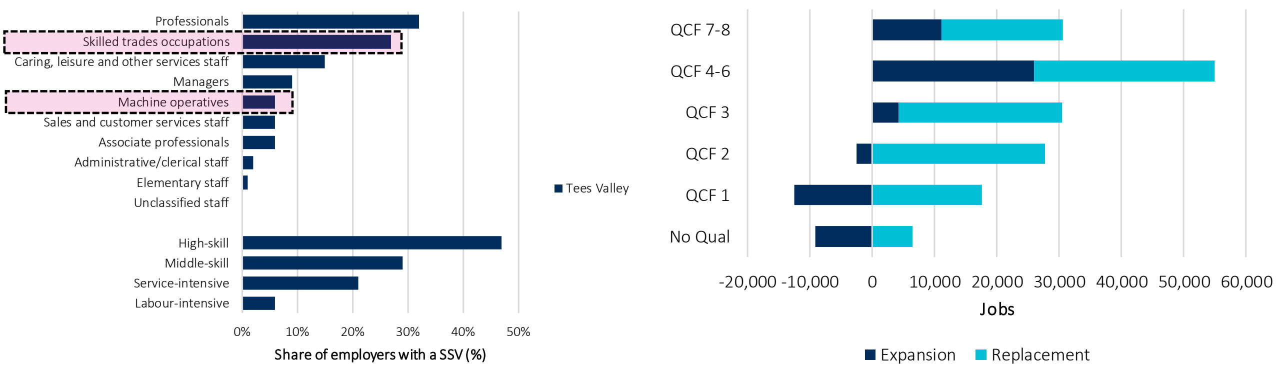
Source: Vivid Economics based on Department for Education (2018) and Working Futures

There is an existing skills gap in professionals, skilled trade occupations and machine operatives that could widen in the future. Demand from NZT will likely widen the existing skills gap in Teesside, with the largest gap likely to be for middle-skill and highly skilled labour during the construction phase. The gap during the

[11] For information on announced and potential closures, see EDF (n.d.) and BBC (2019).

operational phase of NZT could be smaller given the potential closure of the Hartlepool nuclear power station, the announced closure of the INEOS facility, and the existing slack in the chemical and process labour market. However, there could be a skills gap for enabled fabrication jobs. Figure 21 sets out the likely skills gaps.

Figure 21 Skills availability gap analysis



Source: Vivid Economics based on Department for Education (2018) and Working Futures

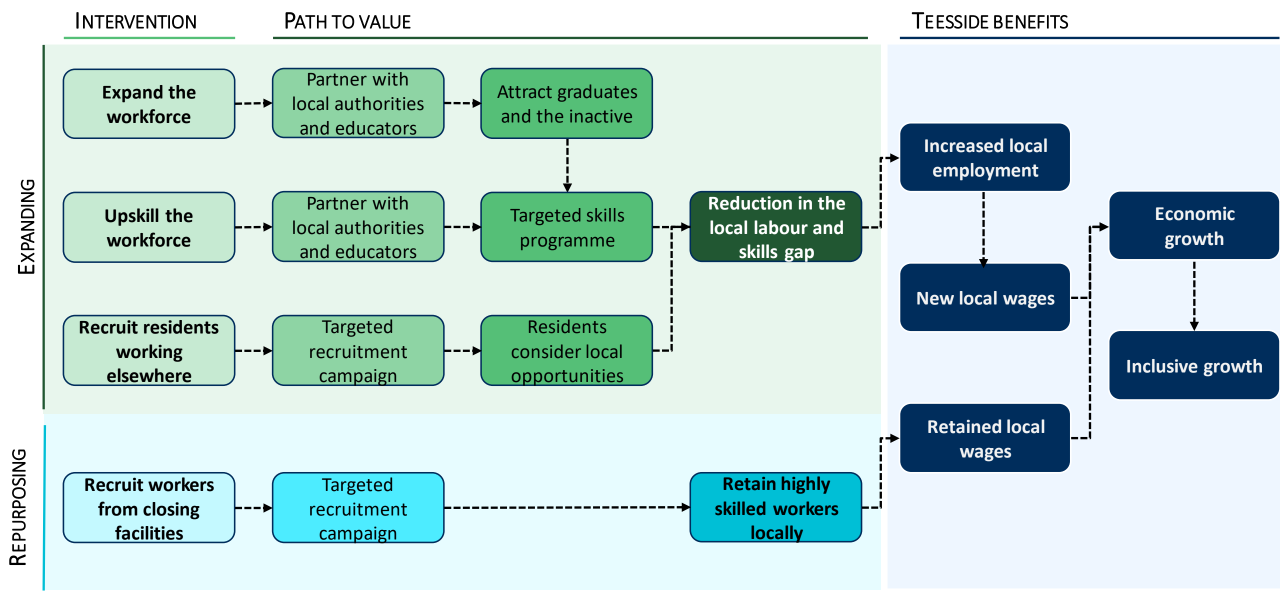
If planned and announced infrastructure investments go ahead, NZT will compete with infrastructure projects throughout the UK for construction contractors and workers. Given the existing infrastructure project pipeline and announced infrastructure spending commitments by government, competition for UK contractors and workers is likely to increase to 2025. This includes the £410 billion in planned infrastructure spending identified by the UK government's National Infrastructure and Construction Pipeline, of which £190 billion is planned for energy infrastructure (Infrastructure and Projects Authority, 2019), and the £640 billion in infrastructure spending over the next five years announced in this year's budget (The Construction Index, 2020). Cumulatively, this level of investment is equivalent to approximately 50% of 2019 UK GDP.

Brexit is likely to reduce the supply of available labour, particularly the supply of unskilled labour. The impact of Brexit is uncertain; however, it is very likely that unskilled migrant labour will be heavily restricted. This is likely to have the largest impact during the construction phase of NZT. Under existing immigration rules, Brexit is unlikely to affect the supply of specific highly skilled occupations. There are multiple STEM (science, technology, engineering and mathematics) occupations relevant for NZT on the government's Shortage Occupation List, including: scientists (biological, biochemists, geologists, geophysicists); engineers (civil, electrical, mechanical, process); high-integrity pipe welders; and IT professionals (Home Office, 2020). These less stringent migrant restrictions on highly skilled labour and the potential slack in the chemical and process labour market could soften the impact of Brexit on the availability of O&M workers during the operational phase of NZT. There is also the potential for unskilled labour in Teesside to benefit from Brexit if unskilled labour can be brought back into the labour force or if Brexit brings new government funding to upskill local labour.

5.2 Interventions

Upskilling and actively recruiting workers will be essential in order to employ local workers during each phase of the NZT project. To achieve this, NZT could undertake targeted interventions to reduce the local labour and skills gap and help deliver economic benefits to Tees Valley. Interventions need to target expanding the number of new graduates and upskilling existing workers. The region has already adopted various policy interventions to manage local labour markets and there is an opportunity to partner with local education providers to help bridge the skills and labour gaps. Potential education partners include Teesside University, University of Durham and Institute of Technology Northeast. Interview evidence suggests that there are substantial numbers of highly skilled Teesside residents, currently working elsewhere in the UK or abroad, who could be re-based in Teesside if offered the right role. There is also an opportunity for targeted recruitment of highly skilled operations workers currently employed at power and industrial facilities that have announced closures or could potentially close by 2025. Figure 22 sets out how these interventions can reduce the labour and skills gap and deliver economic benefits to Tees Valley.

Figure 22 Tees Valley workforce intervention theory of change



Source: Vivid Economics

5.3 Case studies

Box 3 Best-practice case study: Offshore Wind Sector Deal

The Offshore Wind Sector Deal includes numerous skill commitments by industry:

- Develop a skills training needs analysis and an accreditation framework to broaden the skills base
- Investment in Talent Group (central government, devolved administrations and other sectors will also participate). This includes the development of an Offshore Energy Passport for workers to allow the transferral of worker credentials and qualifications across offshore energy projects
- Introduce a workforce and skills model to track and report workforce data, including a skills gap analysis using a model developed by the National Skills Academy for Rail (NSAR)
- Increase diversity in the workforce
- Collaboration to ensure the highest health and safety standards during development, construction, operation and decommissioning
- Build early-stage skills and knowledge accessibility
- Collaborations with universities will be expanded to support research and cultivate a highly skilled RD&D workforce
- Review apprenticeship standards and increase apprenticeships (target set at the end of 2019: 3,000 from 2020 to 2030)
- Project Aura led by the University of Hull
- Numerous RD&D commitments, which indirectly support skills

(HM Government, 2019)

Box 4 Best-practice case study: Crossrail Skills and Employment Strategy

The Crossrail Skills and Employment Strategy set out how Crossrail could best generate the skills and resources required to deliver the largest infrastructure project in Europe. It focused on providing local people with the opportunity to work on the project, and on ensuring that workforce had the skills to deliver the project and maintain it in the future. Interventions included:

- Partnership with JobCentre Plus
- Establishment of the Tunnelling and Underground Construction Agency (TUCA)
- Establishment of a major apprenticeship programme
- Establishment of the Young Crossrail Programme

Crossrail also commissioned a workforce profile that consulted with contractors on their anticipated labour needs and benchmarked these against recent major construction projects, such as the 2012 London Olympic Games. As a result, the workforce profile identified an insufficient supply of tunnellers, which prompted the establishment of the TUCA.

The Crossrail Skills and Employment Strategy was governed by four clear objectives:

1. **Maintaining Safety—**to mainstream safety and ensure that it is at the heart of all aspects of work
2. **Inspiring Future Talent—**to motivate young people to pursue careers in construction and engineering
3. **Supporting Local Labour—**to develop the skills of local people to gain employment within the Crossrail Programme
4. **Revitalising the Skills Base—**to promote the benefits of developing TUCA for the industry

Box 5 Best-practice case study: National Skills Academy for Rail

The NSAR advocates and supports the rail sector in delivering a modern, efficient, world-class railway through the development of a highly skilled and productive workforce. It offers services to firms in the rail industry, including:

- Strategic workforce planning (including skills gap analysis)
- Apprenticeship service
- Placement service
- Bid support
- Quality assurance
- Training facilities and academies

The Offshore Wind Sector Deal cites the NSAR skills gap analysis as the best-practice model to emulate in identifying where there are skills gaps.

6 Conclusion

NZT offers the opportunity for an economic, social and environmental regeneration of the Tees Valley and for the UK to take the first step in unlocking the long-term benefits of CCUS. NZT could bring decades of employment and economic activity to Teesside, help the UK meet its net zero emissions target, and position the UK CCUS supply chain to design, deliver and operate CCUS projects at home and abroad. This will safeguard and enable new energy-intensive jobs in Tees Valley and set up British industry to produce low-carbon products which could one day fetch a premium in carbon-constrained world markets. The key findings and recommendations from this report are set out below.

Key finding 1: NZT could support up to 4,500 direct jobs during the construction phase (2024–28) and 900 jobs during the operation phase (2030–50).[12] This includes a mix of EPCm, installation and manufacturing jobs during the construction phase. and O&M jobs during the operation phase. During the construction phase, NZT could also support 13,500 indirect and induced jobs annually from increased spending in the supply chain and the regional and national economy.

Key finding 2: From 2020 to 2050, NZT could support £4.8 billion in cumulative GVA (undiscounted). During the construction phase, NZT could support £370m in GVA per year on average, and £120 million in GVA per year on average during the operation phase of the project. Economic activity during the construction phase is concentrated in Teesside, with some GVA generated throughout the UK from the sale of services and manufacture of components, while economic activity during the operation phase is almost entirely generated in Teesside. During the construction phase, NZT could also support £750 million in indirect and induced GVA annually from increased economic activity in the supply chain and the regional economy.

Key finding 3: NZT supports the development of the UK CCUS supply chain, including the provision of CCUS services such as engineering and the manufacture of CCUS components such as advanced solvents and speciality instruments. This helps the UK maximise future benefits from CCUS as the UK deploys up to 173 Mtpa by 2050 and positions UK firms to win exports contracts as the world deploys more than 3,000 Mtpa of capture by 2050.[13] If the UK deploys commercial-scale CCUS clusters before international competitors and leverages existing strengths in related industries, its domestic market could support £1.6 billion in GVA and 18,000 direct jobs annually by 2030, and the export of CCUS goods and services could support £1.2 billion in GVA and 13,000 direct jobs annually by 2040.

Key finding 4: The global market for CCUS goods and services is a substantial opportunity for UK firms, with the global market potentially reaching over £150 billion in turnover annually by 2040. The UK is well placed to export CCUS services given existing strengths in engineering and sector strengths in oil and gas and chemicals. To maximise benefits from export markets, it is essential that the UK deploys CCUS before competitors in order to build the expertise and track record that UK firms need to win export contracts. The direct benefits from UK exports, including GVA and employment, could nearly match the direct economic benefits from the domestic market if the world deploys CCUS in line with the IEA's ETP 2-degree scenario.

[12] NZT envisions capturing 10.2 Mtpa by deploying 2.1 GW of gas CCUS, retrofitting 0.4 GW of BECCS and capturing 1.4 Mtpa from existing industries at Teesside.
[13] UK deployment scenario is based on the 'Further Ambition' scenario in the CCC's net zero advice to government, and the global deployment scenario is based on the IEA ETP 2-degree scenario.

Recommendation 1: The UK must deploy at least one CCUS cluster by 2030 in order to maximise direct benefits and position the UK as a leader in CCUS. This will help UK firms capture and lock in a share of the global market for CCUS goods and services. Moving first will require support from government to ensure that CCUS projects are built and that concerted action is taken by industry to leverage existing strengths. Waiting another decade to deploy CCUS will reduce direct benefits from the domestic market and could lock UK firms out of export markets.

Key finding 5: The UK is likely to be a strong competitor in CCUS services, but there is an opportunity for targeted supply chain interventions and higher levels of innovation to further increase the level of UK content in CCUS projects. Higher levels of UK content generate more direct benefits for the UK. Higher levels of support can also safeguard the direct benefits set out above. For example, if the sector were to target increasing UK content by 20% in each market, a level of ambition similar to that adopted in the Offshore Wind Sector Deal, this could support an additional 5,000 jobs throughout the UK. Higher levels of innovation and supply chain support also mitigate trade-offs between UK content and consumer costs by positioning UK suppliers as preferred suppliers for both cost and quality reasons.

Recommendation 2: In order to maximise the benefits to the UK, government and industry could fund supply chain support, including supplier and innovation support. If government can ensure certainty of return for CCUS developers, industry could be well placed to provide support to suppliers. Government is best placed to provide support to increase innovation spending and should do so in order to meet a range of existing policy objectives, including net zero emissions, levelling up regions and increasing RD&D spending to 2.4% of GDP. As a first step, CCUS developers could adopt contractual enforcement of UK content reporting in order to facilitate a bottom-up estimate of UK content and to assist supplier selection.

Key finding 6: The Tees Valley labour market is weaker than the national labour market and there is a skills shortage. Unemployment in Tees Valley is 75% higher than the national average, and Tees Valley has a higher share of economically inactive people than the national average. However, throughout 2019, there were 27,500 job vacancies advertised online in Tees Valley—the equivalent to 10% of existing jobs. High levels of unemployment and economic inactivity despite existing vacancies suggest a skills mismatch. Employers reporting skills shortages in Tees Valley confirm this, with skills in IT, Construction, Education and Manufacturing roles in the highest demand. Given projected labour demand, the gap for construction workers will likely widen by 2025, particularly if infrastructure spending increases in line with government plans. The gap for operations workers could be reduced by 2025 if announced and potential closures of power and industrial facilities in Tees Valley occur.

Recommendation 3: To maximise local participation in the project, NZT should consider undertaking targeted interventions to reduce the local labour and skills gap and help deliver economic benefits to Tees Valley. Interventions need to target expanding the number of new graduates and upskilling existing workers. The region has already adopted various policy interventions to manage local labour markets, and there is an opportunity to partner with local education providers to help bridge the skills and labour gaps. This could be augmented with a targeted recruitment strategy to recruit both highly skilled Teesside residents currently working elsewhere in the UK or abroad and highly skilled operations workers currently employed at power and industrial facilities in Tees Valley that have announced closures or could potentially close by 2025.

References

BBC (2019) INEOS chemical plant to close with 145 job losses: https://www.bbc.co.uk/news/uk-england-tees-50830573

BEIS (2019a) Digest of United Kingdom Energy Statistics: https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

BEIS (2019b) Energy Innovation Needs Assessment Sub-theme report: Carbon capture, utilisation, and storage: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845655/energy-innovation-needs-assessment-ccus.pdf

CCC (2019) Net Zero Technical Report: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf

The Construction Index (2020) Budget 2020: £128bn a year for infrastructure: https://www.theconstructionindex.co.uk/news/view/budget-2020-128bn-a-year-for-infrastructure

Crossrail (2016) Crossrail Skills & Employment Strategy: https://learninglegacy.crossrail.co.uk/documents/crossrail-skills-employment-strategy/

DECC (2011), Guidance on estimating carbon values beyond 2050: an interim approach: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48108/1_20100120165619_e____carbonvaluesbeyond2050.pdf

Department for Education (2018) Employer skills survey 2017: England and local toolkit: https://www.gov.uk/government/publications/employer-skills-survey-2017-england-and-local-toolkit

EDF (accessed 2020) Hartlepool power station: https://www.edfenergy.com/energy/power-stations/hartlepool

Element Energy (2010) One North Sea: A study into North Sea cross-border CO_2 transport and storage: http://www.element-energy.co.uk/wordpress/wp-content/uploads/2010/08/OneNorthSea.pdf

Equinor (2020) Northern Lights well completed: https://www.equinor.com/en/news/2020-03-05-northern-lights.html

European Commission (2019) supplementing Directive 2003/87/EC of the European Parliament and of the Council concerning the determination of sectors and subsectors deemed at risk of carbon leakage for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/GA/TXT/?uri=CELEX:32019D0708

European Commission (n.d.) SETIS: Dr. Lothar Mennicken talking to SETIS: https://setis.ec.europa.eu/publications/setis-magazine/carbon-capture-utilisation-and-storage

Eurostat (accessed 2020) Prodcom: https://ec.europa.eu/eurostat/web/prodcom/data/database

Global CCS Institute (2019) Global Status of CCS 2019: https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf

H21 (2018) H21 North of England: https://www.h21.green/wp-content/uploads/2019/01/H21-NoE-PRINT-PDF-FINAL-1.pdf

HM Government (2019) Offshore Wind Sector Deal: https://www.gov.uk/government/publications/offshore-wind-sector-deal

HM Treasury (2020) Budget Speech 2020: https://www.gov.uk/government/speeches/budget-speech-2020

Home Office (2020) Immigration Rules Appendix K: shortage occupation list: https://www.gov.uk/guidance/immigration-rules/immigration-rules-appendix-k-shortage-occupation-list

IEA (2017) Energy Technology Perspectives: https://www.iea.org/reports/energy-technology-perspectives-2017

Infrastructure and Projects Authority (2019) National Infrastructure and Construction Pipeline 2018: https://www.gov.uk/government/publications/national-infrastructure-and-construction-pipeline-2018

LANUV (n.d.) Treibhausgas-Emissionsinventar Nordrhein-Westfalen 2016, n.d. https://www.lanuv.nrw.de/publikationen/details/?tx_cart_product%5Bproduct%5D=907&cHash=dad63a68b0d7e0b7e2fc5224ff05ea19

Leeson et al. (2017) A Techno-economic analysis and systematic review of carbon capture and storage (CCS) applied to the iron and steel, cement, oil refining and pulp and paper industries, as well as other high purity sources: https://www.sciencedirect.com/science/article/pii/S175058361730289X

Leigh Fisher (2016) Electricity Generation Costs and Hurdle Rates: Lot 3: Non-Renewable Technologies: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/566803/Leigh_Fisher_Non-renewable_Generation_Cost.pdf

National Skills Academy for Rail (2018) Overview Brochure: https://www.nsar.co.uk/wp-content/uploads/2018/11/NSAR-Overview-Brochure-Version-19.pdf

ONS (2019a) Annual Business Survey: Non-financial business economy, UK: Sections A to S: https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas

ONS (2019b) Annual Population Survey: https://www.nomisweb.co.uk/articles/1167.aspx

ONS (2018) Business Register and Employment Survey: https://www.nomisweb.co.uk/datasets/newbres6pub

Poyry and Element Energy (2015) Potential CCS Cost Reduction Mechanisms Report: https://www.theccc.org.uk/publication/poyry-element-energy2015-potential-ccs-cost-reduction-mechanisms-report/poyry-element-energy2015-potential-ccs-cost-reduction-mechanisms-report/

STDC (2019) South Tees Regeneration Master Plan: https://www.southteesdc.com/wp-content/uploads/2020/01/South-Tees-Master-Plan-Nov-19.2.pdf

TVCA (2020) 2019 Tees Valley Economic Assessment (forthcoming)

UN (accessed 2020) Comtrade Database: https://comtrade.un.org/

Wood (2018) Assessing the Cost Reduction Potential and Competitiveness of Novel (Next Generation) UK Carbon Capture Technology: Benchmarking State-of-the-art and Next Generation Technologies: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/864688/BEIS_Final_Benchmarks_Report_Rev_4A.pdf

Zero Carbon Humber (2019) The Vision: https://www.zerocarbonhumber.co.uk/the-vision/

Technical annex

This annex sets out the steps, data and assumptions used to estimate the direct, indirect and induced benefits set out in the main report. Additional information for the results presented above and the methodologies described below can be found in the three supporting technical annexes that complement this section. The three supporting technical annexes include:

- NZT Economic Benefits
- NZT Supply Chain Scenarios
- NZT Labour Supply and Skills Analysis

Direct benefits

Direct benefits are estimated as follows:

Domestic market:

1. Estimate turnover for the UK market for goods and services based on:
    a. UK CCUS deployment scenario (based on the CCC Further Ambition scenario)
    b. CCUS costs by component to 2050 (e.g. DEVEX, EPCm, capture components, O&M)
2. Determine the level of UK content by component (based on UK market share of similar goods and services today based on Eurostat Prodcom and BEIS, 2019b)
3. Estimate turnover captured by UK firms supplying the UK market (% UK content * market turnover)
4. Estimate GVA and jobs from captured turnover using GVA multipliers and GVA per worker ratios from the ONS Annual Business Survey (2019)

Export market:

1. Estimate turnover for the global market for goods and services based on:
    a. CCUS deployment scenario for key markets (EU27, RoW) (IEA, 2017)
    b. CCUS costs by component to 2050 (e.g. DEVEX, EPCm, capture components, O&M)
2. Determine the level of UK content by component for each key market (based on UK share of similar goods and services today based on UN Comtrade and BEIS, 2019b)
3. Estimate turnover captured by UK firms supplying global markets (% UK content * market turnover)
4. Estimate GVA and jobs from captured turnover using GVA multipliers and GVA per worker ratios from the ONS Annual Business Survey (2019)

UK CCUS deployment profiles:

- **Gas CCS:** UK deployment follows the NZT deployment pathway to 2030, then increases linearly to the 2050 CCC Further Ambition target. All gas CCS is new build as by 2030 all existing unabated gas generation is more than halfway through its lifetime (the newest unabated CCGT facility's lifetime is exhausted by 2041) (BEIS, 2019a).
- **BECCS:** UK deployment follows the NZT and Drax deployment pathways to 2035 (Zero Carbon Humber, 2019), then increases linearly to the 2050 CCC Further Ambition target. Existing stock commissioned after 2010 is retrofitted until all post-2010 stock is retrofitted by 2036 (3.2 GW retrofitted) (BEIS, 2019a).

- **Industry:** The UK deploys industry CCUS gradually until 2035. The rate of deployment between 2020 and 2035 is assumed to be half the rate of post-2035 deployment. After 2035, industry deployment increases linearly to the 2050 CCC Further Ambition target. Industry deployment profiles are indicative and adjusted according to the steps above.
- **Hydrogen:** UK deployment follows NZT and H21 North of England deployment pathways to 2034 (H21, 2018), then increases linearly to the 2050 CCC Further Ambition target (CCC, 2019). Only NZT existing hydrogen production is retrofitted; the rest of UK deployment is new build.
- **Transport and storage:** CO_2 transport and storage is deployed to meet the volumes produced.

Costs

- **Gas CCS**: Cost data is from Wood (2018) and indexed to the Poyry and Element Energy (2015) cost curve to account for FOAK and NOAK cost differences.
- **BECCS:** Cost data is from Wood (2018) and indexed to the Poyry and Element Energy (2015) cost curve to account for FOAK and NOAK cost differences.
- **Industry:** Cost data is derived from Leeson et al. (2017).
- **Transport and storage:** Cost data is from Leigh Fisher (2016). Costs start at the Leigh Fisher high estimate in 2020 and decline to the Leigh Fisher low estimate by 2050.
- **Hydrogen production:** Cost data is from H21 (2018) for projects built from 2020 to 2035. thereafter project costs decline at the same rate as power projects from 2035 to 2050.

Key assumptions

- Project lifetimes: power, hydrogen, transport & storage: 25 years, industry: 35 years
- The modelling assumes repowering to maintain cumulative scenario deployment levels at end of facility lifetimes
- Expenditure schedules: DEVEX: five years, CAPEX: four years
- Capture volumes per GW of capacity for gas CCS derived from Wood (2018) (2.68 Mtpa/GW)
- Capture volumes per GW of capacity for BECCS and hydrogen derived from the CCC's Net Zero report (7 Mtpa/GW for BECCS, 2 Mtpa/GW for hydrogen) (CCC, 2019)
- Retrofit costs derived from Wood (2018)—modelling assumes retrofit CAPEX is 38% of new build and OPEX is 67% of new build
- NZT assumes CCUS retrofits of existing hydrogen production and biomass and energy-from-waste generation at Teesside
- Teesside Future assumes CCUS retrofits of existing hydrogen production at Teesside and then new build once existing hydrogen production is retrofitted

For more information see the NZT Economic Benefits supporting technical annex.

Indirect and induced benefits

Indirect and induced benefits are estimated using the Vivid Investment Impact Model (IIM). For the UK economy, the model is calibrated to account for the interactions between 127 sectors, in order to provide an accurate picture of the supply chain impacts from NZT.

The IIM estimates the impact on GDP of an increase in output from NZT, based on the existing average technology observed in the I/O tables from the ONS. The tables take the form of a square matrix, where outputs are calculated down the columns of the matrix, and inputs fed in via rows (that is, column X gives the output of sector X, while row X gives the sectors that use sector X as an input). The I/O table approach provides a complete high-level picture of the UK economy, including economic activity in 127 sectors and household consumption. GDP effects can be extracted using either the final demand approach or the factor payments approach.

From the I/O tables, we built a schematic representation of all transactions happening in the UK economy, in the form of a Social Accounting Matrix (SAM). The SAM is easier to interpret as all economic agents are represented in a single matrix: firms, households, government and foreign sector. Yet, the relationships are those provided by the I/O tables, so both terms can be used interchangeably. The column header is the buyer and the row header the seller. Hence, activities (firms) buy inputs from domestic output and imported goods, which taken together amount to the total intermediate demand. Similarly, activities need inputs from the factors of production to produce (labour and capital). The columns of activities provide payments to factors accounting for these transactions.

The model implicitly makes three major assumptions:

1. **Constant returns to scale as production is increased:** in other words, the empirical technology observed in the I/O tables is assumed to be the same at any level of production.
2. **Slack capacity:** there is enough underused capacity in the economy to scale up production without requiring additional investment.
3. **Fixed prices:** the model does not allow for price adjustments. This assumption is critical, as the model does not consider substitution effects between inputs, but rather assumes they will always be used in the same proportions. In the short run this is a reasonable assumption, yet in the longer run, prices will adjust to reflect the increase in demand. As a result, the estimated impact is likely to be slightly larger than the actual effect after prices adjust (upwards), and should be taken as an upper-bound estimate in the long run.

We calibrate a series of modules to assess the indirect and induced distributional effects of the investment shock from NZT:

- **Gross Value Added (GVA):** we transform the total impact on domestic production into GVA. The model nets out all domestic and imported inputs required to produce the total domestic impact. This is equivalent to adding factor payments together, that is labour and capital, and adjusting for indirect taxes. For this work, we split the effect between indirect and induced impact to assess the relative magnitudes of each one. Estimating the indirect impact requires exhausting all the higher-order effects (i.e. remove the value of the inputs of the inputs of the inputs, etc). This exercise also allows for isolation of the total increase in domestic demand for intermediate inputs. From there we get induced effect by removing from the total domestic impact both the NZT investment shock and intermediate domestic inputs. Finally, to transform induced production into induced GVA, we proceed with a similar exercise of netting out the value of inputs until exhaustion.
- **Employment:** first we estimate the increase in total labour payments in each sector. We combine this output with the latest data on average salaries per sector from the ONS to estimate the employment

impact. Using the indirect and induced effects describe above, we also produce the job estimates using that level of disaggregation.

Supported and safeguarded and enabled jobs

Supported and safeguarded jobs are estimated based on existing employment in energy-intensive industries in Tees Valley today. This is set out in the following steps:

1. The ONS Business Register and Employment Survey estimates existing employment at the local authority level by NACE (Nomenclature of Economic Activities) sector at the four-digit level (ONS, 2018).
2. Employment in the Tees Valley is estimated at the NACE four-digit level by aggregating employment in Darlington, Hartlepool, Middlesbrough, Redcar and Cleveland and Stockton-on-Tees.
3. We assume that jobs at risk are likely to be in sectors at risk of offshoring production due to carbon taxes. This offshoring is known as 'carbon leakage'.
4. The European Commission provides a list of sectors at the NACE four-digit level deemed at risk of carbon leakage based on the emissions intensity and trade exposure of these specific sectors (European Commission, 2019).
5. Employment in Tees Valley at risk from carbon leakage is identified by combining the ONS Business Register and Employment Survey with the European Commission's carbon leakage list.
6. The low estimate applies the European Commission's carbon leakage list at the NACE four-digit level (e.g. manufacture of other organic basic chemicals, NACE 20.14).
7. The high estimate assumes that associated sectors are likely to be negatively impacted from carbon leakage in a specific related sector and applies the carbon leakage list at the NACE two-digit level (e.g. manufacture of chemicals and chemical products, NACE 20).
8. For example, the European Commission considers the manufacture of synthetic rubber in primary forms (NACE 20.17) at risk of carbon leakage, but not the manufacture of pesticides and other agrochemical products (NACE 20.20). The low estimate considers only employment in NACE 20.17 at risk, while the high estimate considers all employment at the NACE 20 level at risk.
9. We assume that the implementation of the NZT project provides Tees Valley firms with access to a carbon capture network and low-carbon fuels (e.g. hydrogen), allowing production at risk of carbon leakage to de-risk by reducing carbon intensity and differentiating products to increase international competitiveness and maintain today's employment levels.

Enabled jobs are estimated based on potential employment in energy intensive sectors targeted by the STDC Master Plan (STDC, 2019)**.** The is set out in the steps below:

1. The STDC Master Plan Dashboard (v2) provides a potential pool of jobs enabled by the industrial transformation outlined by the STDC strategy
2. EITE jobs are identified based on the European Commission's carbon leakage NACE sector list (i.e. sectors at risk of production offshoring due to differences in emissions intensity between trade partners).
3. The Master Plan does not identify potential jobs by NACE sector so best judgement is used to match potential jobs/facilities to the carbon leakage NACE sectors.
4. We assume these jobs are enabled with access to carbon capture and low-carbon fuels, which enhance international competitiveness by reducing emissions and intensity and allowing for low-carbon product differentiation.

Company profile

Vivid Economics is a leading strategic economics consultancy with global reach. We strive to create lasting value for our clients, both in government and the private sector, and for society at large.

We are a premier consultant in the policy-commerce interface and resource- and environment-intensive sectors, where we advise on the most critical and complex policy and commercial questions facing clients around the world. The success we bring to our clients reflects a strong partnership culture, solid foundation of skills and analytical assets, and close cooperation with a large network of contacts across key organisations.

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