CarbonNet

CCS Regional Economic Benefit Assessment - Gippsland

February 2021

Executive summary

The construction of CarbonNet and resulting activity from CCS enabled industries has the potential to provide a significant economic boost to Victoria

$896m

The CarbonNet project has the potential to provide an estimated $896m boost annually to Victoria's Gross State Product (GSP) annually during the construction phase

2,707 jobs

The CarbonNet project could create an average of 2,707 total jobs per annum during construction phase for Victoria with the majority of jobs in Gippsland

$1,056m

CarbonNet's CCS industries have the potential to increase Victoria's GSP by $1,056m annually, once it becomes operational, driven primarily by the production of CCS enabled industries
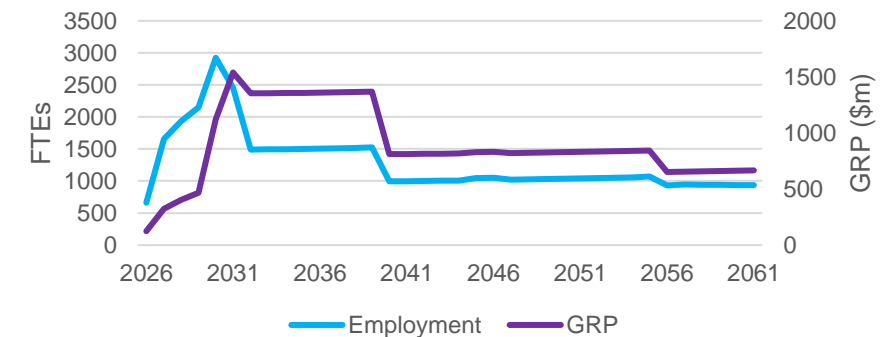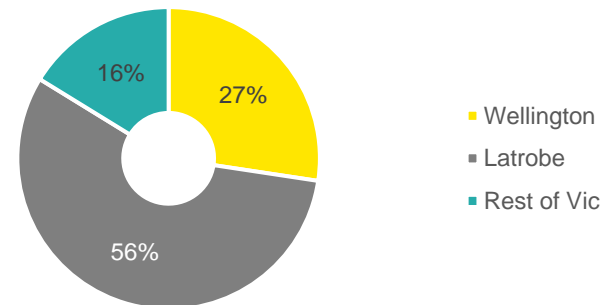
1,176 jobs

CarbonNet's CCS industries could create an additional 1,176 jobs per annum for CCS enabled industries while operational. This figure includes both direct (through the operation of CarbonNet and CCS enabled industries) and indirect employment supported by the project

CarbonNet and CCS can help to achieve sustainable industry development and economic growth for the Latrobe and Wellington LGAs

CCS is expected to facilitate long-term economic benefits for the region in terms of its impact on Gross Regional Product (GRP) and employment. As shown in the figure opposite, the impact of the project is expected to be most significant in the final stages of construction (2030/31) and followed by a sustained boost to GRP and employment through to 2061.

Legend: Employment (blue), GRP (purple). X-axis years 2026–2061. Left axis FTEs (0–3500), Right axis GRP ($m) (0–2000).

Flow on impacts of CarbonNet's CCS industries will be highly beneficial for Victoria

Donut chart: Wellington 27%, Latrobe 56%, Rest of Vic 16%

Direct project spending will flow throughout the Victorian economy, Gippsland will see most benefit with 16% of total benefits provided outside of Latrobe and Wellington LGAs.

CarbonNet can provide significant environmental and social benefits

The project will enable the decarbonisation of industry and help to achieve a **low-emissions future**
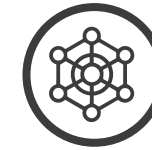
The attraction of new business will provide **agglomeration** benefits through knowledge sharing and other spill-over impacts

The project has the capacity to create new jobs and training opportunities which will ensure **sustainable growth** for the region

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Introduction

Background

About the project

The CarbonNet Project (CarbonNet or the Project) is investigating the potential for establishing a commercial-scale carbon capture and storage (CCS) network in Gippsland (in the Latrobe and Wellington LGAs). CCS involves capturing carbon dioxide (CO_2) released by industrial processes, compressing it and then transporting it to an injection site to be sequestered deep underground for safe, long-term storage in suitable geological formations. The network would bring together multiple CO_2 capture projects, transporting CO_2 via a shared pipeline and injecting it into deep underground, offshore storage sites in Bass Strait.

The project was established by the Victorian government in 2009 and has been jointly funded by the State and Commonwealth since 2010. Since 2010 CarbonNet has completed extensive investigations which have been subject to independent review and certification, including detailed modelling of potential CO_2 storage sites in Bass Strait. The project also secured legal access to offshore sites enabling further field activities to take place to confirm the viability of multiple locations.

The project is currently in Stage 3: Project Development and Commercial Establishment, and the drilling of an offshore appraisal well in 2019-20 at the Pelican site in Bass Strait.

The primary focus of this stage of the project is now defining the commercial structure and underlying principles to attract private sector investment. Various investment scenarios are being examined to understand the potential impacts of a CCS service to industry in Gippsland, such as the Hydrogen Energy Supply Chain (HESC) project.

Purpose of the analysis

The purpose of this report is to provide a detailed economic assessment that captures both the direct and indirect economic benefits related to the construction of the CarbonNet project and the operation of enabled industries, based on a range of key assumptions regarding the level of commercialisation of the project developed in close consultation with the CarbonNet team.

The analysis provided in this report is intended to assist CarbonNet in communicating the broader economic benefits of the project to key stakeholders and the community.
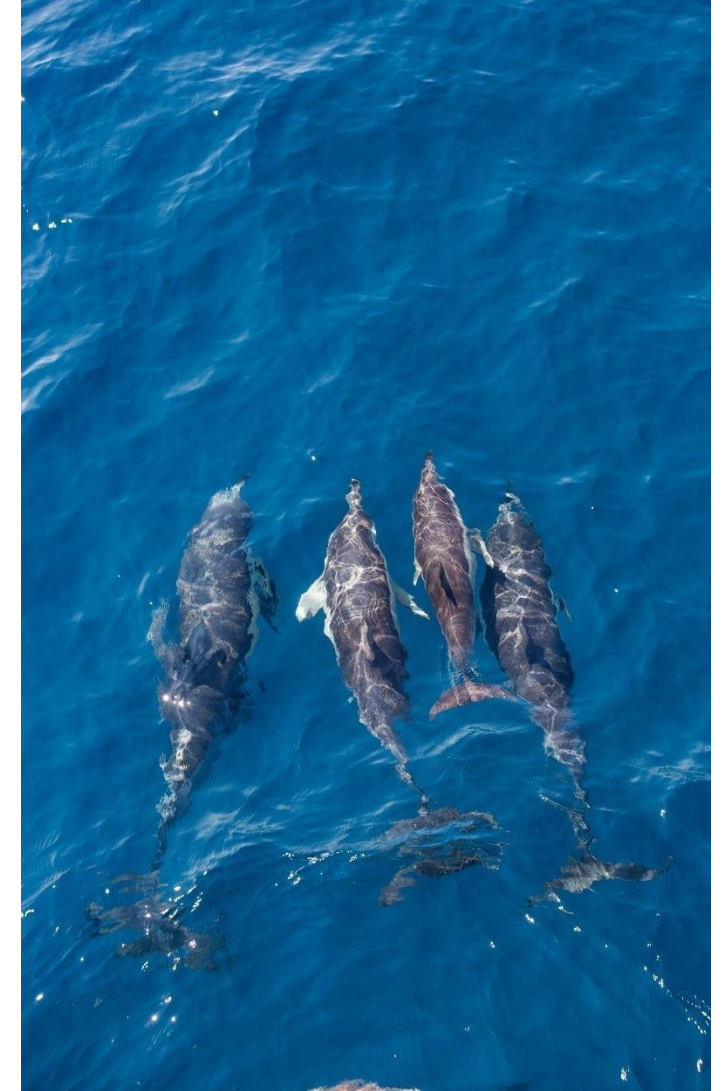
Location of the CarbonNet project

Why Gippsland?

In 2009 the Gippsland region was identified as the most attractive region for CCS in Australia by the national Carbon Storage Taskforce. Victoria has the opportunity to lead the rest of Australia in contributing to Australia's emissions mitigation commitments and in establishing Australia's first CCS industry hub.

The Gippsland Basin is a world-class hydrocarbon producing region with well understood geology and significant subsurface storage potential in both unfilled structures and oil and gas reservoirs when depleted, with an estimated potential storage capacity exceeding 31,000,000 MT. This estimate of capacity is informed by extensive oil and gas exploration and production across the Gippsland Basin over the past 50 years, which has produced an extensive open-source geological data archive of the Basin.

CarbonNet has used this archive to assess CCS prospectivity across the Gippsland Basin. CarbonNet has demonstrated that the Gippsland Basin compares most favourably in a global context with excellent high injectivity reservoirs, proven multiple seals, large structural closures and no pressure issues due to an extensive offshore aquifer system.

The Pelican site

Detailed 3D geological models of the Basin enabled geologists and reservoir engineers to analyse a number of sites and to predict the behaviour of CO_2 throughout the storage process, from injection to migration and stabilisation.

Initially, 14 sites were identified in the nearshore area. This was eventually reduced to three, with Pelican prioritised as CarbonNet's initial carbon dioxide (CO_2) storage site. Located in the offshore Gippsland Basin in Bass Strait, Pelican is a very large, dome shaped geological structure that has many rock layers.

The porous layers of sandstone, approximately 1.5km below the seabed, act like a sponge to store the CO_2, while layers of shale and coal form the barriers to trap the CO_2 – the same way oil and gas has been trapped in Bass Strait naturally for millions of years. Pelican is large enough to store at least five million tonnes of CO_2 per year for 25 years.

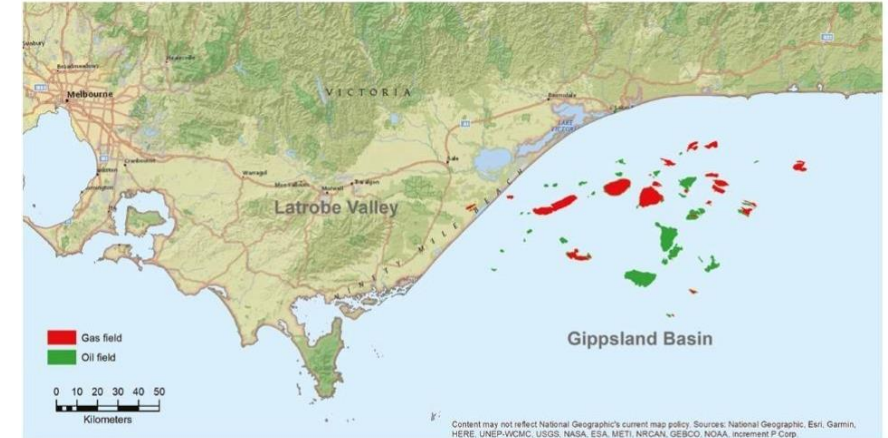**Figure 1 – CarbonNet Project regional context**

Figure 2 – Greenhouse gas permits for the offshore Pelican site

Economic profile of the Gippsland region

Situated in south-east Victoria, the Gippsland region is comprised of six local government areas (LGAs), or shires: East Gippsland, Wellington, Baw prospectively, Latrobe, South Gippsland and Bass Coast. The Gippsland region has a population over 286,000, and in 2019 the Gross Regional Product (GRP) was $17.7b, which accounts for approximately 3.9% of Victoria's Gross State Product (GSP). There are approximately 105,700 workers employed in the region, with the highest employing industries being health care, retail trade and construction.

The Gippsland region hosts a wide array of processing facilities and gas pipelines, while the Gippsland Basin is Victoria's most productive petroleum province. Exploration since the 1960s has yielded several world class oil and gas fields as well as numerous small and medium sized fields. One notable example is the Kingfish oil field, which was discovered in 1967 and remains Australia's largest petroleum discovery.

The region is considered a traditional energy powerhouse and produces the majority of Victoria's electricity from Latrobe Valley's brown coal-fired generators, as well as 97% of Victoria's natural gas, and 14% of Australia's oil from Bass Strait's extensive gas and oil fields. Gas produced from the Gippsland Basin services Melbourne, regional centres across Victoria as well as the wider east-coast gas market.

However, with the changing energy landscape, traditional electricity generation methods are challenged by the need to lower greenhouse gas emissions. All of Latrobe Valley's coal-fired power stations are scheduled to close by 2048, which will see significant changes to the industrial and employment landscape in the Latrobe Valley and wider Gippsland.

The CarbonNet project represents a significant opportunity for the region, with potential for CCS to be established in the Bass Strait. The project would provide both a short-term economic boost during construction, and also help to activate and support both existing and emerging industries. By providing industry with an incentive to locate within the region, the project has the potential to serve as a cornerstone on which the region's existing assets and natural advantages can be leveraged.

$17.7b
Gross Regional Product
(3.9% of VIC GSP)

105,700
Workers employed
(3.9% of total VIC employment)

Focus areas

Healthcare and social assistance which accounts for the highest number of jobs in the region, with demand likely to increase due to an ageing population
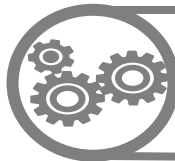
Advanced Manufacturing
Skilled and qualified workforce and opportunities for industry to leverage advancements in science and tech in the region

Food and Fibre the projected increase in global demand for food and fibre represents an exciting opportunity for the region; however climate change remains a key challenge for industry

Energy The changing energy landscape is causing traditional electricity generation methods to be challenged by the need to lower greenhouse gas emissions

Resources and Mining the transition towards low-emissions future represents a challenge in terms of both rehabilitating and transforming existing industry

Knowledge Industry and Professional services a growing number of business incubators and co-working spaces proving successful in growing traditional and developing new industries

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Potential commercial opportunities enabled by CarbonNet

The CarbonNet Project is establishing a commercial scale Carbon Capture and Storage (CCS) network in Gippsland, Victoria, with the vision of the project being to develop a world class, commercially viable CCS hub in Gippsland that provides a safe, competitive, flexible solution for Victoria to manage its future carbon emissions from industrial sources, while supporting economic development opportunities.

Successful implementation of this project will lead to a commercial scale carbon transportation and storage system, introducing new industries, creating new jobs for the Latrobe Valley, and enabling significant reduction in CO_2 emissions in Victoria. The most prospective of these opportunities are outlined in the figure below.

Hydrogen
With carbon capture and storage, hydrogen can be produced directly from coal with near-zero greenhouse gas emissions.

Waste to Energy
CCS provides a pathway for the WtE industry to achieve negative CO_2 emissions while producing the power and handling the waste produced by our growing populations and economies.
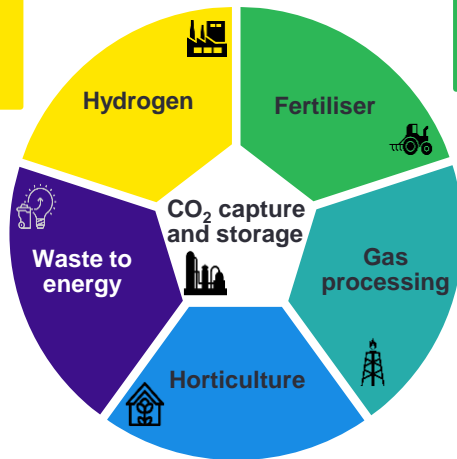
Fertiliser
CCS will provide a cost effective opportunity for the commercial fertiliser industry to decarbonise operations.

Gas processing
CCS is well suited to natural gas processing as CO_2 is removed from gas before it can be transported or used.

Horticulture
CCS will allow the horticulture industry to utilise CO_2 in greenhouses which will help to improve productivity of the industry.

Hydrogen · Fertiliser · CO_2 capture and storage · Waste to energy · Gas processing · Horticulture

Hydrogen Energy Supply Chain (HESC) project

The Hydrogen Energy Supply Chain (HESC) project aims to safely produce and transport clean liquid hydrogen from Australia's Latrobe Valley.

The HESC Project is being developed in two phases, beginning with a pilot which is developing a complete hydrogen supply chain, creating hydrogen gas via the gasification of Latrobe Valley coal, transport to the Port of Hastings for liquefaction, and shipment to Japan.

A commercial scale HESC Project will require a CCS solution.

The project has the potential to be a game-changer - providing an innovative, economically viable and environmentally conscious solution to producing clean hydrogen safely, through gasification of coal with CCS. Producing clean hydrogen with coal also provides a viable roadmap for the Latrobe Valley's energy workers looking to transition to a new industry. A commercial HESC Project has the potential to create thousands of sustainable jobs in the region and create a thriving hydrogen export industry with huge local economic benefits.

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Approach

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Approach overview

The purpose of this study was to provide an independent assessment of the potential economic benefits of the CarbonNet project to Victoria and to help communicate the scope and extent of these benefits to the community. To achieve this, EY has undertaken a detailed economic impact assessment using Computable General Equilibrium (CGE) modelling. The economic modelling utilised EY's in-house EYGEM model to estimate the potential impact of the CarbonNet project and CCS enabled industries on economic output and employment within the Latrobe and Wellington LGAs, as well as the rest of Victoria. The analysis is supported by a qualitative assessment of the potential social and environmental benefits of the project to provide a comprehensive assessment of the CarbonNet project. The figure below provides a summary of the approach undertaken.

1 ————— **2** ————— **3** ————— **4** —————▶

Define the scope of the CarbonNet project

► EY worked closely with the CarbonNet team in defining the scope and scale of the CCS enabled industries

► Developed appraisal framework that describes the potential impacts and benefits of the project

► Developed relevant scenarios to represent varying levels of investment and utilisation of the project

► Consulted with DJPR and other key stakeholders to gather data and to validate key modelling assumptions.

Gather and refine model inputs

► Define key regions for analysis

► The key inputs to estimate the economic impact of the project are:
   ► Capital expenditure
   ► Operating expenditure
   ► Industry expenditure

► The economic modelling has been informed by data gathered by the CarbonNet team through the investigative process

► Projected industry expenditure has been estimated based on consultation with industry and validation against publicly available benchmarks.

CGE modelling and scenario analysis

► Calibrate and validate model to ensure that the model accurately reflects the economic environment of the defined regions of analysis

► Identify key sensitivities and defined appropriate scenarios to estimate the impact of key uncertainties (e.g. capacity, utilisation, pricing)

► In addition to testing the various sensitivities described in step 2, additional scenario analysis was also undertaken to understand the impact of changes to various input assumptions of the CGE model such as the employment elasticity

► For further details on the in-house CGE EYGEM model, refer to Appendices A, B and C.

Assess broader social and environmental benefits of the project

► It is acknowledged that the economic impact analysis does not fully capture the total value that Victoria will receive from the CarbonNet project

► Therefore, a qualitative assessment has been undertaken to examine the broader social and cultural benefits of the project, and their potential contribution to Victoria.

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Regional assumptions for economic modelling of CarbonNet

Regions defined in the CGE model

An important assumption in the CGE model is the location of activity as this will dictate which regions will be 'shocked'. Key regions have been defined within the CGE model based on the local government area (LGA) where activity is anticipated to be undertaken

Based on consultation with the CarbonNet team, the following activities and corresponding regions have been defined within the model:

► **Customer activity (i.e. production of hydrogen, fertiliser etc) and carbon capture** is assumed to occur across the Wellington and Latrobe LGAs.

► **Carbon dioxide transport and storage** is assumed to occur in the LGA of Wellington (although storage will technically happen off the coast)

Within the CGE model, four separate regions have been defined which allows the economic flows between regions to be modelled and estimated. The regions that are defined within the EYGEM model are:

► Latrobe

► Wellington region

► Rest of Victoria (RoVIC)

► Rest of Australia (RoA)

► Rest of World (RoW)

For the purposes of this report, only the economics impact for the Latrobe and Wellington region and Victoria have been presented.
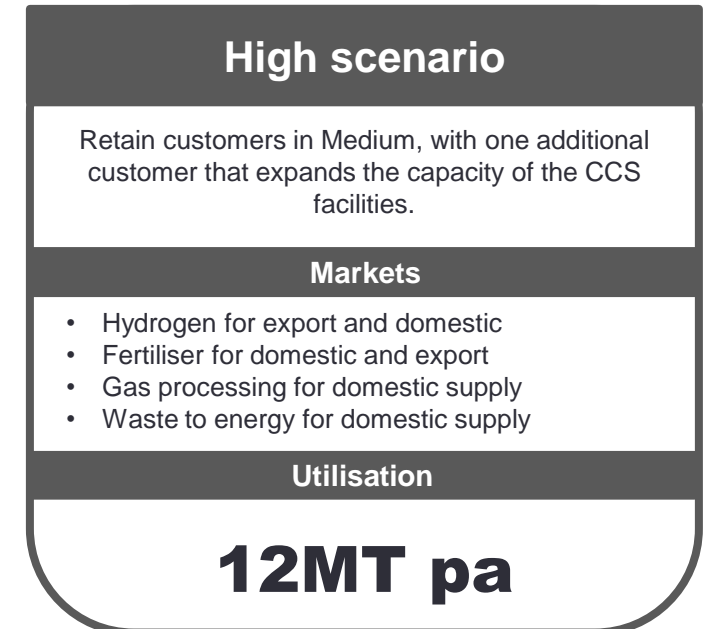
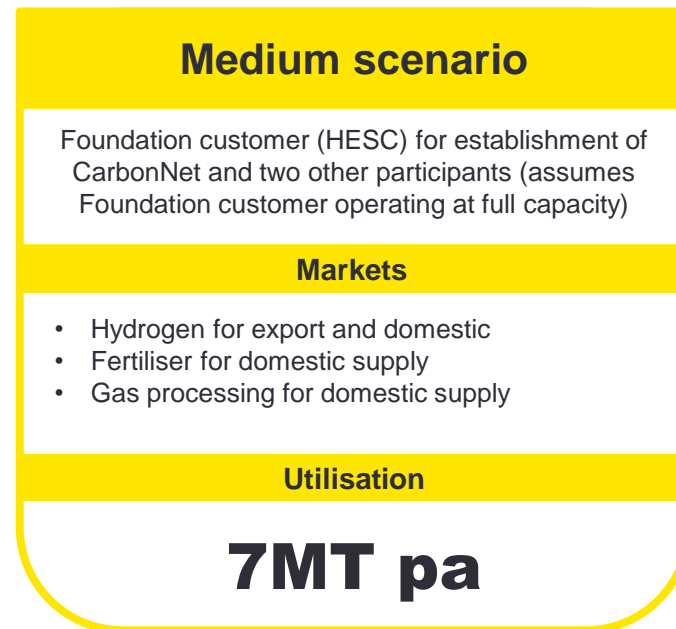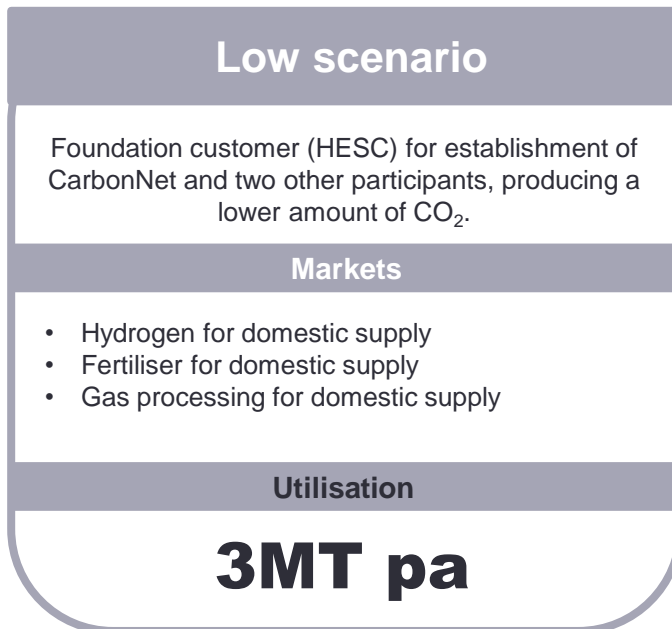**Figure 3 – Economic modelling regions**
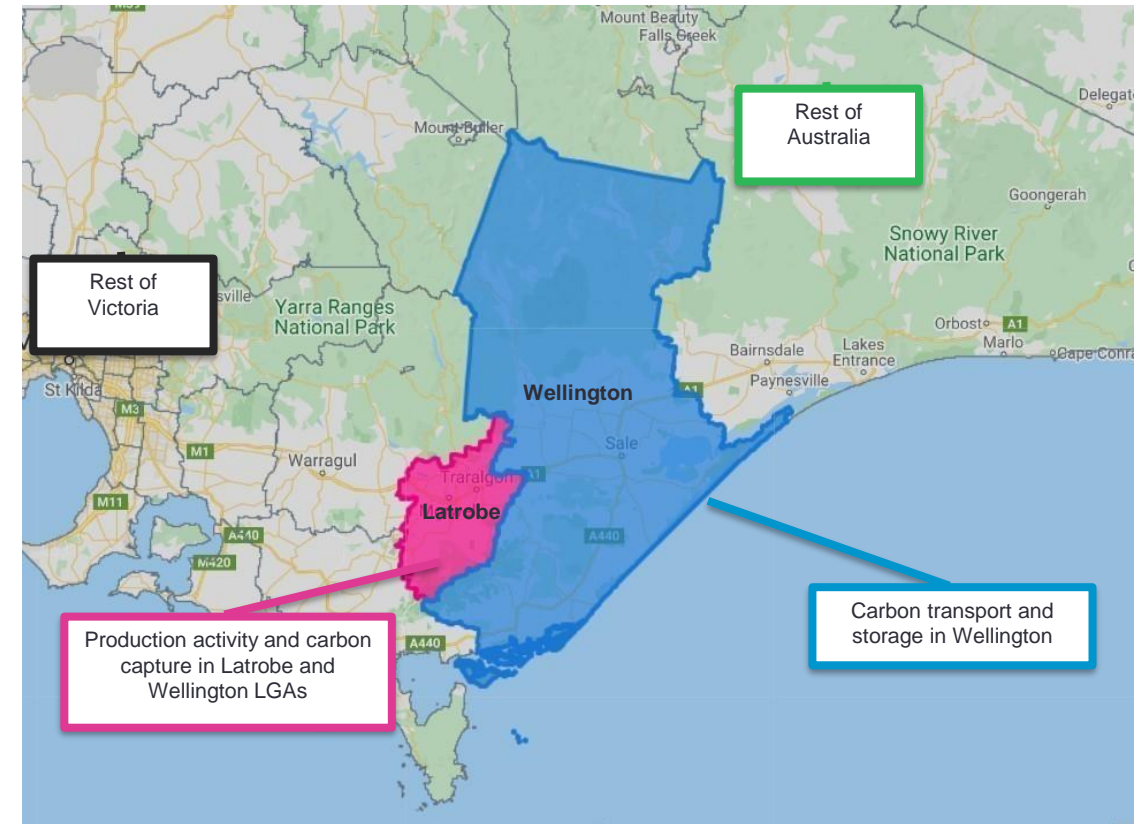
Modelling scenarios and assumptions

A critical component of the economic analysis is to identify the implications and impacts of different project specifications in order to understand the range of potential impacts. The modelling is based on three scenarios developed to represent varying levels of capital investment, and operational activity, in particular the balance between export and domestic use.

The 'Medium scenario' represents a forward view where the HESC project operates at anticipated full capacity, with a total of 4.2Mt of CO_2 to be stored per annum. The HESC project is joined by two other customers, producing a combination of hydrogen, fertiliser and natural gas, for a total annual storage requirement of 7Mt of CO_2.

Two additional scenarios were also developed to understand the sensitivity of the project to changes in customer output and annual storage requirements. In the "Low Scenario" sensitivity, we test the impact of the foundation customer operating at lower than anticipated capacity and two other customers producing a combination of hydrogen, fertiliser and natural gas for a total annual output of 3Mt of CO_2. In the "High Scenario" sensitivity, we test three customers being retained with output matching the Medium scenario, with another customer contributing additional fertiliser and hydrogen production with 4Mt of annual CO_2 to be stored, and a further 1Mt of CO_2 from waste to energy and biomass electricity production.

Each of these scenarios have been modelled using EY's CGE tool, with the outputs used to understand both the direct and indirect impacts to the local economy and to Victoria.

Low scenario	Medium scenario	High scenario
Foundation customer (HESC) for establishment of CarbonNet and two other participants, producing a lower amount of CO_2.	Foundation customer (HESC) for establishment of CarbonNet and two other participants (assumes Foundation customer operating at full capacity)	Retain customers in Medium, with one additional customer that expands the capacity of the CCS facilities.
Markets	**Markets**	**Markets**
• Hydrogen for domestic supply • Fertiliser for domestic supply • Gas processing for domestic supply	• Hydrogen for export and domestic • Fertiliser for domestic supply • Gas processing for domestic supply	• Hydrogen for export and domestic • Fertiliser for domestic and export • Gas processing for domestic supply • Waste to energy for domestic supply
Utilisation	**Utilisation**	**Utilisation**
3MT pa	**7MT pa**	**12MT pa**

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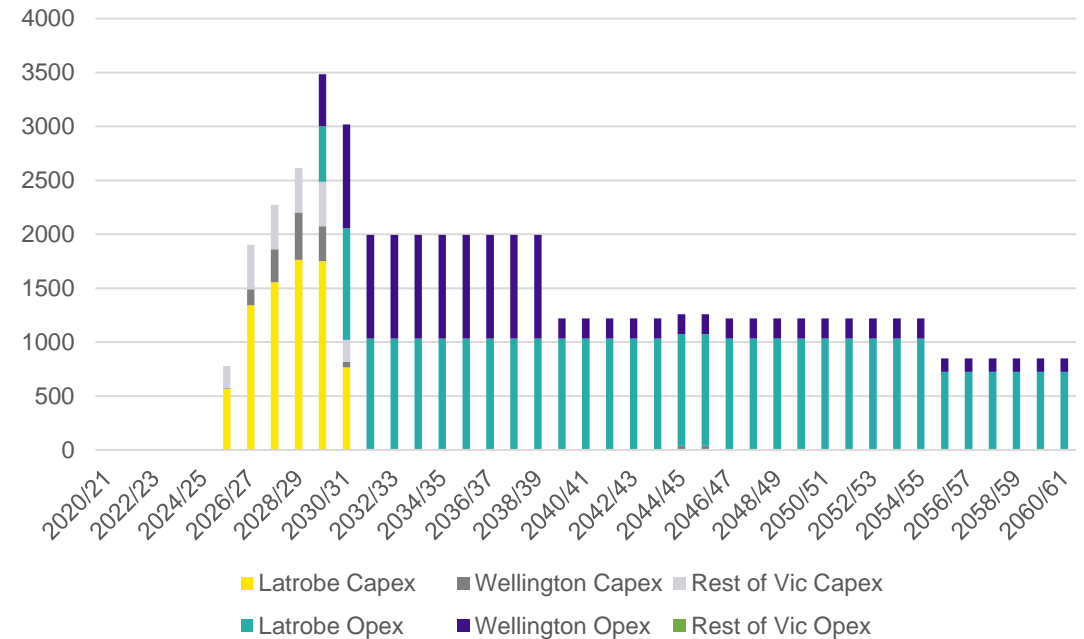
Economic benefits of CarbonNet

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Expenditure of CCS enabled industries

A key component of the economic modelling is to establish the projected expenditure profiles of CCS enabled industries so that economic impacts of these expenditures can be modelled. These expenditures include both the upfront capital investment related to the construction of the necessary infrastructure (construction phase), and the ongoing production expenditure of each of the enabled industries (operational phase).

EY has worked closely with the CarbonNet team to develop the following expenditure profiles based on the proposed scope of the project, while also utilising key industry benchmarks to estimate the production expenditure from industries that would be activated by the CarbonNet project. The table below provides a summary of the capital and expenditure profiles for the Medium scenario, while Figure 4 provides a time series comparison of the expenditure profiles between the different scenarios modelled.

Figure 4 – CarbonNet Capex and Opex Profile – Medium Scenario

Capital investment (Medium scenario)	Production value (Medium scenario)
$11.1b over 6 years	**$1.2b p.a. in opex**

The construction of the projects (CarbonNet and enabled projects) is estimated to be $11.1b over 6 years.

The capital expenditure profile is presented in Figure 3, representing the total cost of construction including the carbon transportation (pipeline) in Wellington, the construction of fertiliser manufacturing plants, the construction for the natural gas extraction, and the construction of bioenergy plants (in the high scenario).

The operational phase of CarbonNet is assumed to begin immediately after construction is complete in 2030-31.

The key operating expenditure streams will include production of hydrogen from the foundation customer (HESC), production of fertiliser in Latrobe for both export and domestic consumption and the generation of electricity through the biomass plants to be sold domestically.

$960m p.a. in Latrobe   **$230m p.a. in Wellington**

Low scenario	High scenario
$5.0b in capital investment **$591M p.a.** in production value	**$19.3b** in capital investment **$1.6b p.a.** in production value

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Economic impact results summary (Medium scenario)

The economic analysis demonstrates that the CarbonNet project has the potential to provide a significant economic impact to the Latrobe and Wellington LGAs by providing a substantial boost to the Gross Regional Product (GRP) of the region during both the construction and operational phases of the project, while also creating new employment opportunities within the region.

Additionally, the flow-on impacts from the project are expected to provide further economic benefits throughout the rest of Victoria, generating additional economic activity and employment opportunities across the State.

From a whole of Victoria perspective, CarbonNet is projected to provide an additional $896m to the Gross State Product (GSP) and 2,707 jobs annually during the construction phase of the project.

Once CarbonNet becomes operational, the activity of CCS enabled industries is projected to increase Victoria's GSP by $1,056m annually, while also supporting an additional 1,176 jobs each year during the operational phase. This employment impact includes both the direct (i.e. employment related to the operation of CarbonNet and CCS enabled industries) and indirect jobs that will be created as a result of the project.

The following figures provide a summary of the average annual economic impact provided by the project during each phase of the project's lifecycle.

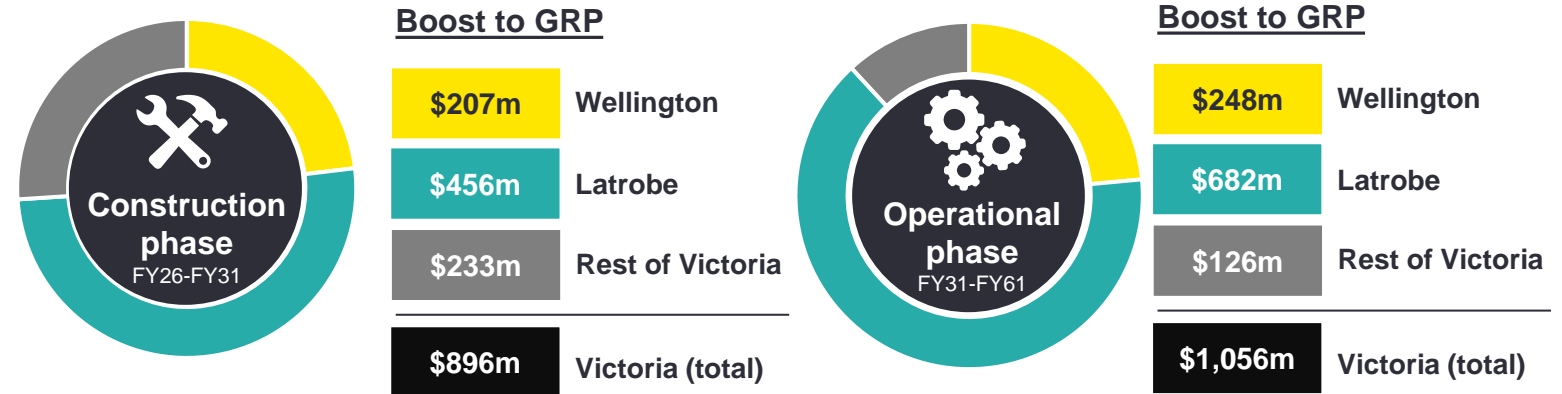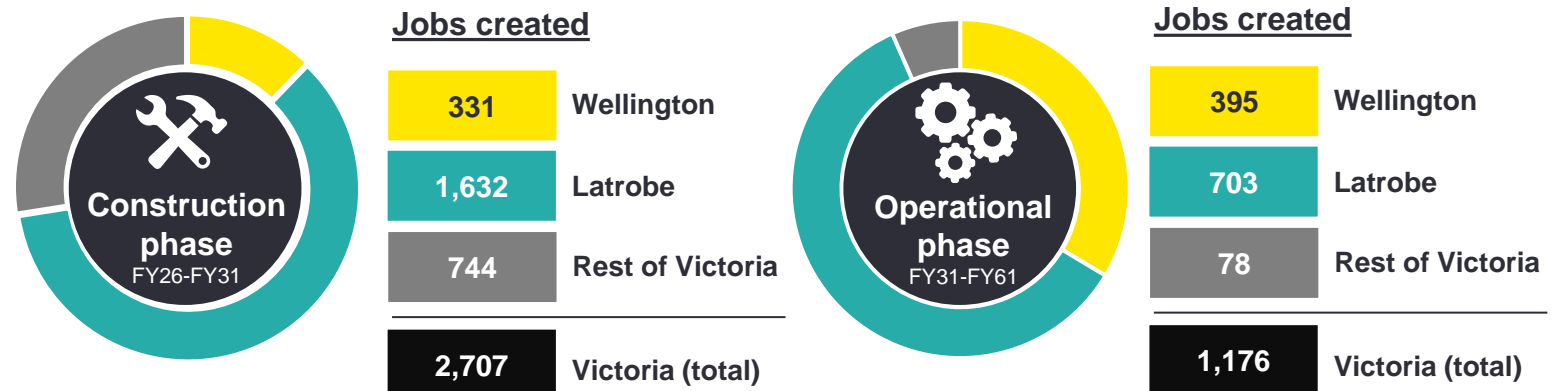**Figure 5 – Economic impact on Gross Regional Product (Medium scenario) – Average annual impact**

Construction phase FY26-FY31 — Boost to GRP:
- $207m Wellington
- $456m Latrobe
- $233m Rest of Victoria
- $896m Victoria (total)

Operational phase FY31-FY61 — Boost to GRP:
- $248m Wellington
- $682m Latrobe
- $126m Rest of Victoria
- $1,056m Victoria (total)

Figure 6 – Economic impact on employment (Medium scenario) – Average annual impact

Construction phase FY26-FY31 — Jobs created:
- 331 Wellington
- 1,632 Latrobe
- 744 Rest of Victoria
- 2,707 Victoria (total)

Operational phase FY31-FY61 — Jobs created:
- 395 Wellington
- 703 Latrobe
- 78 Rest of Victoria
- 1,176 Victoria (total)

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Economic impacts for Latrobe and Wellington

Impact on economic growth (Gross Regional Product)

EY's economic modelling shows a strong positive impact of the CarbonNet project (medium scenario) on the Gross Regional Product (GRP) of Latrobe and Wellington local government areas (LGAs).

The construction phase of the project provides for a strong boost to GRP in each of the regions, as to be expected for such a significant investment pipeline, with a peak combined increase in GRP of over $1.5b in 2030/31. Over this period, the majority of the capital investment and hence the greatest share of the economic benefits accrues to the Latrobe region.

Once the operational phase of the project commences the impact to GRP maintains a strong impact of approximately $1.3b to 2038/39 above the levels expected without the CarbonNet project. As shown in the figure below, the Latrobe region will see a more significant impact on GRP over this period, largely due to increased output of high productivity industries already established within the region.

Figure 7 – GRP impacts in Latrobe and Wellington (Medium scenario)
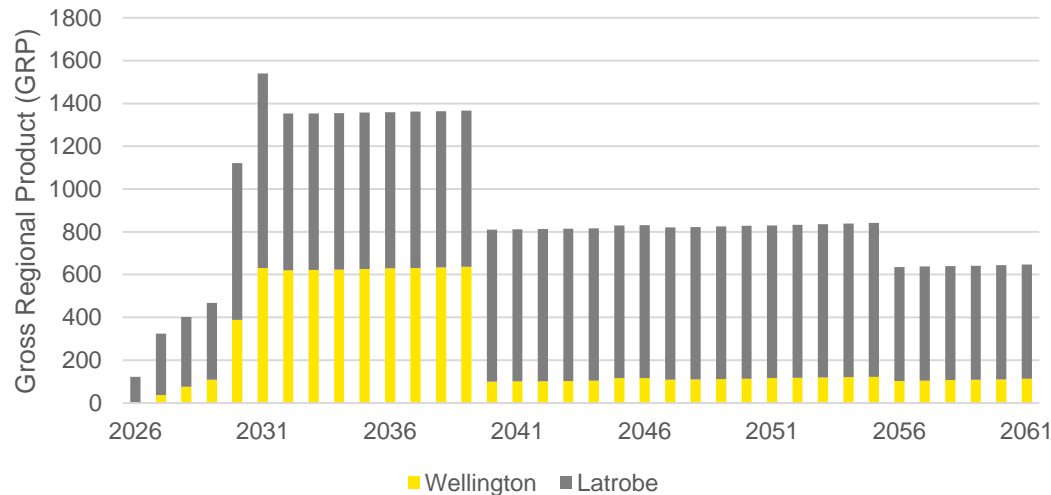
Impact on regional employment (FTE)

Economic modelling of the CarbonNet project scenario shows a strong positive employment impact (measured by FTE) in both the Latrobe and Wellington LGAs.

During the construction phase of the project (under the medium scenario) the total number of local jobs (direct and indirect jobs) created increase sharply, peaking at 2,342 in Latrobe and 959 in Wellington, with employment concentrated in the construction industry.

During operations the structural differences in the customer base between the regions distributes benefits more broadly, and while a greater share of the GRP impacts fall to the Latrobe region, Wellington enjoys a greater share of the employment benefits, largely due to the presence of more labour intensive industries in the region.

During the initial operational phase between 2030 to 2038, modelling shows that approximately 1,500 direct and indirect jobs will be added to Wellington and Latrobe. While the majority of GRP impact will occur in Latrobe (as shown on Figure 7), Wellington will account for a greater proportion of the jobs created due to the capital intensive nature of the industries impacted in the Latrobe region.

While the modelling suggests a reduction in economic activity between 2038 and 2055 due to the assumed lifespan of CarbonNet foundation customers, based on global trends it is expected that new industries would emerge focused on carbon negative opportunities - biomass and direct air capture. This is supported by a recent report by IEA* which highlights the need for carbon removal approaches to achieve net negative emissions after 2050.

Figure 8 – Employment impact in Latrobe and Wellington (Medium scenario)

https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

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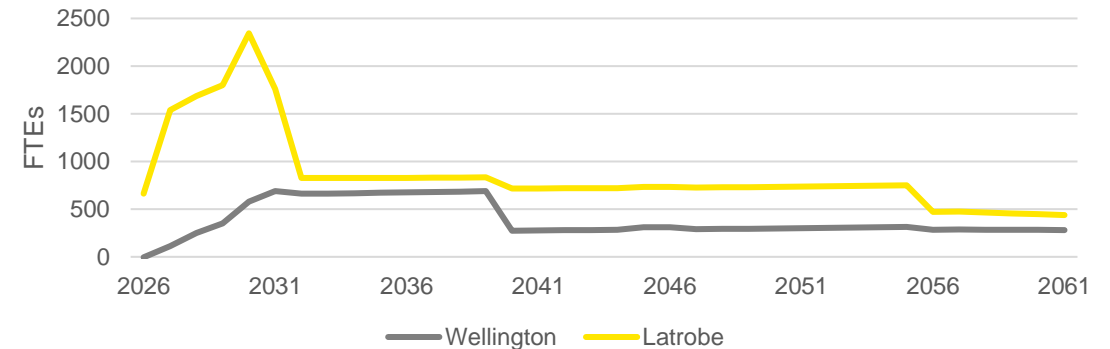
Economic impacts for Victoria

Impact on economic growth (Gross State Product)

EY's economic modelling shows a strong positive impact of the CarbonNet project (medium scenario) on the Gross State Product (GSP) of the State of Victoria.

The construction phase of the project provides a strong positive impact to GSP, peaking at $1.8b in 2030/31.

After operations commence in 2030, the impact to GSP stabilises at approximately $1.5b to 2038/39, once again moderating over time as selected customers are assumed to reach end of life, in the same way as was observed previously for the combined Wellington and Latrobe region.

In the high growth scenario (see page 20), GSP follows a similar pattern, peaking at over $1.8b and then stabilising at approximately $1.6b for the start of the operational phase, and moderating as select customers cease operations.

Impact on State-wide employment (FTE)

Economic modelling of the CarbonNet project scenario shows a strong positive employment impact (measured by FTE) in at the statewide level.
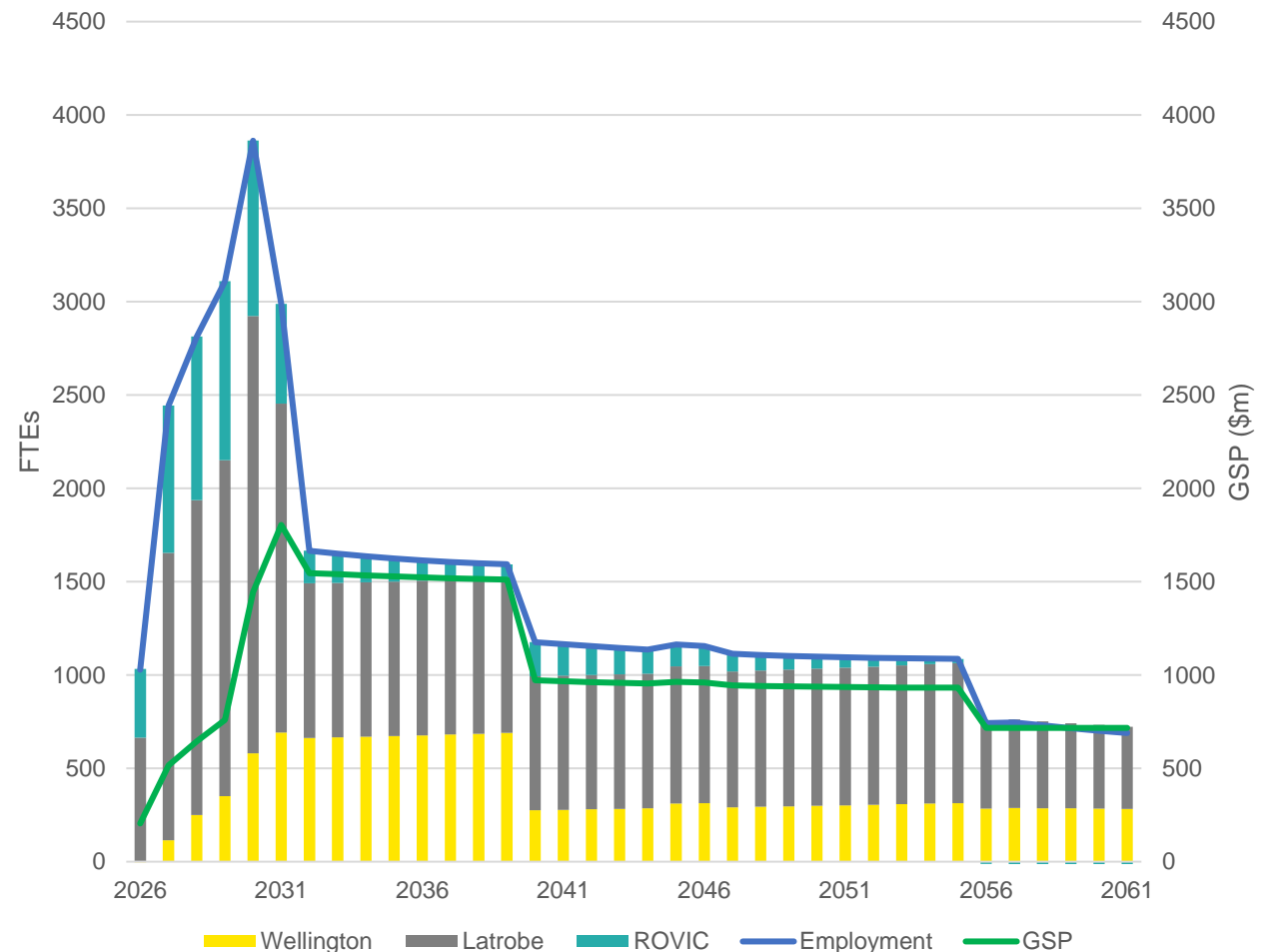
During the construction phase of the project (under the medium scenario) the number of Victorian jobs increase sharply, peaking at 3,862, with employment concentrated in the construction sector.

During the initial operational phase between 2030 to 2038, modelling shows that approximately 1,500 jobs will be added (with 55% going to Latrobe and 45% to Wellington), with a significant portion of these occurring in the gas industry.

Between 2038 and 2055, as the project's operational expenditure reduces, the number of additional jobs associated with CarbonNet reduces to approximately 1,000 FTE across the State, reducing to below approximately 900 after 2055.

In the high growth scenario, employment growth is expected to peak at 6,119 across the state (centred in Latrobe and Wellington), then maintain approximately 1,600 FTEs through the operational phase to 2038, dropping to similar levels estimated for the medium CarbonNet scenario beyond 2055.

Figure 9 – GSP and employment impact in Victoria

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Industry employment impacts

CarbonNet is projected to drive strong growth in employment not only in Wellington and Latrobe, but with subsequent spillover benefits to the rest of the Victorian economy.

During the construction phase the Latrobe region experiences the greatest increase in economy wide employment driven by the high level of construction activity in that region, with an average of 1,632 more full time equivalent jobs over that period. Due to high level of capital expenditure and significant demand for labour during this period, it is expected that some labour will come from other industries as workers are attracted to new opportunities in the construction sector. However, the analysis suggests there will be no job losses across the region and that the CarbonNet project has a net positive impact on the economy and jobs market.

During the operational phase of the project impacts to other industries are expected to subside, with the employment likely to be spread across industries in line with increased demand amongst CCS enabled industries.

As shown in Figure 11 below, all regions of Victoria are expected to benefit, with the benefits sustained over both the construction and operations phases.

Figure 10 – Average employment impacts by key industry sectors (Wellington and Latrobe)
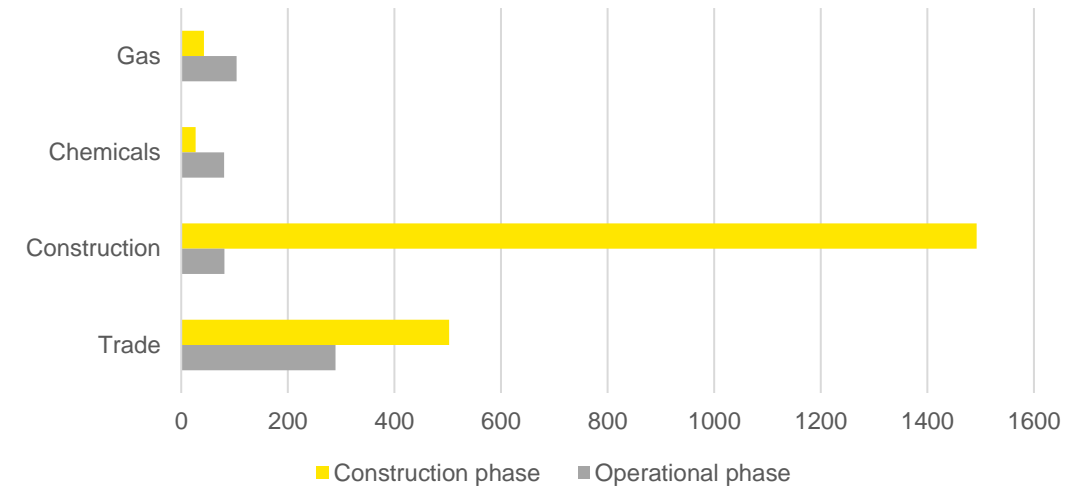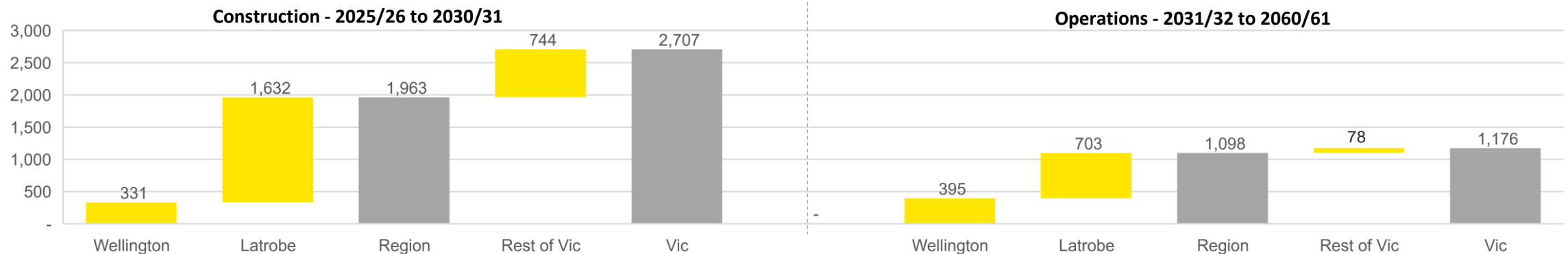
Figure 11 – Average employment impacts by project phase – Medium Scenario

* Other industries include Agriculture, Coal, Oil, Other minerals, Manufacturing, Processed Food, Petroleum and Coal Products, Electricity, Water, Transport, Communications, Finance, Other Business Services, Recreation and Other Government Services

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Scenario results for Latrobe and Wellington

Impact on GRP

Low scenario

In the low scenario, the construction phase of the project creates strong growth in GRP in the Wellington and Latrobe regions, driven by high levels of capital expenditure. After the commencement of the operational phase of the project, the impact to GRP stabilises at approximately $900m in the years 2030 to 2038. As some customers reach end of life the increment reduces to approximately $400m and then further to $330m as the operational expenses fall further in Latrobe.

Medium scenario

Similar to the low scenario, upfront growth in GRP is due to the high capital expenditure in the construction phase, but as CarbonNet moves into operation, there is a greater impact to the GRP due to the increased operational expenditure. Now the project peaks with an impact of $1.5b in the years 2030 to 2038, but this does fall to $930m and fall further to under $720m due to the same type of reductions made in the low scenario.

High scenario

In the high scenario, the GRP follows the same shape as the two previous scenarios, but again due to the higher operational expenses, there is a greater GRP impact for all year, with the peak of $1.8b. Once the operational expenses fall, the GRP is also expected to fall.

Impact on Employment (FTE)

Low scenario

Under the Low Scenario there is strong employment opportunities generated in the Wellington and Latrobe regions during construction phase of the project. The heavy reliance on the construction sector during this phase drives a proportionately high level of employment compared to the sustained increase observed in the operations phase, peaking at over 1,800 FTE in 2029/30. Once ongoing operations commence the level of employment in the region remains above baseline levels, with approximately 1,000 additional FTE employees in the combined region to 2038/39, reducing as customer projects reach end of life over the modelling period.

Medium scenario

The medium scenario follows the same profile as the low scenario as a result of the similar make up of the capital and operational expenses. The number of FTEs peak at 3,000 in 2029/30 and then remains between 720 to 1,500 during the operational phase.

High scenario

In the high scenario, again the employment impact curve follows the same profile as the previous scenarios, now with a peak FTE of 4,900 in 2030. As with the other scenarios, the number of FTEs steadily decline during the operational phase due to a projected reduction in operational expenditure in later years.

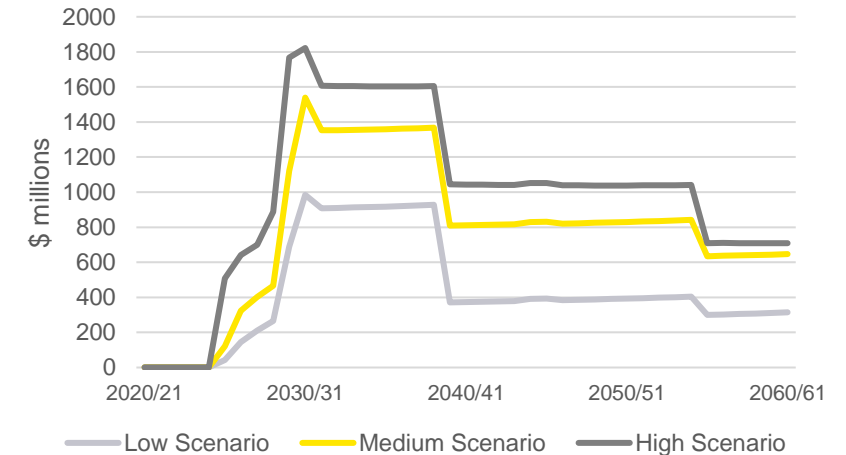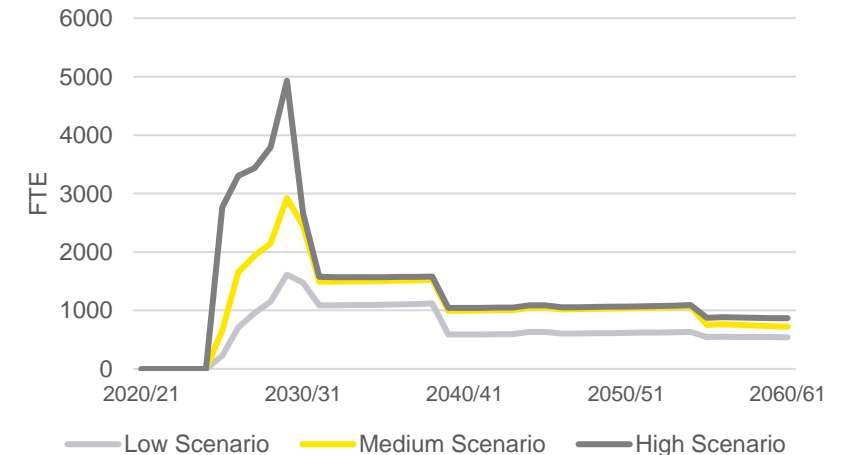**Figure 12 – GRP impact in Latrobe/Wellington ($m)**

Figure 13 – Employment impact in Latrobe/Wellington (FTE)

EY

Scenario results for Victoria (State-wide impacts)

For each scenario modelled, there are flow on effects due to the economic activity in Latrobe/Wellington. The creation of new jobs in Latrobe/Wellington results in changes to the employment in the rest of Victoria, due to the limited supply of labour, and impacts to the output of industries due to supply chains.

Low scenario

Overall, Victoria's GSP and employment increases as a result of the CarbonNet project, with the increase being driven by Latrobe/Wellington region. In the construction phase of the project, the rest of Victoria experiences an overall increase in GRP, driven by greater construction and recreational output.

The Low Scenario sees a peak increase in employment of 1,881 FTE across the state, compared to 1,641 FTE in the Wellington and Latrobe regions alone, an increase of 272 FTE in the Rest of Victoria region. Victorian GSP peaks at an increase of $1,056m compared to $985m in the Wellington and Latrobe region alone, with an increase in economic activity of $71m at the peak for the Rest of Victoria.

Medium scenario

Due to the mix of capital expenditure and operational expenditure, the flow on effects into the rest of Victoria are similar to the previous scenario. However, due to the higher capital expenditure in Latrobe and rest of Victoria, the GRP for the rest of Victoria remains higher than the base for the entire project horizon (until 2061) and the drop in FTE in the rest of Victoria is smaller than that in the low scenario due to smaller losses of employment in the manufacturing industry.

In the Medium scenario the peak Victorian employment is 3,862 FTE compared to 2,922 FTE in the Wellington and Latrobe region, while the peak GSP impact is $1,804m versus $1,540m in the Wellington and Latrobe region.

High scenario

The high scenario has the highest capital and operating expenditure for the Latrobe region, so as a result, the GRP and employment is significantly higher than the other scenarios. However, due to the higher employment in the Latrobe region, this causes greater losses in FTE in both Wellington and the rest of Victoria. Within the rest of Victoria, there is a shift in employment to construction, trade and other services/government away from manufacturing.

In the high scenario, employment is projected to peak at 6,119 FTE across Victoria compared to 4,930 FTE in the project region, and a peak Victorian GSP increase of $2,133m compared to a peak of $1,822 in the Wellington and Latrobe region which demonstrates the significant flow on impacts the project can have on the rest of Victoria.

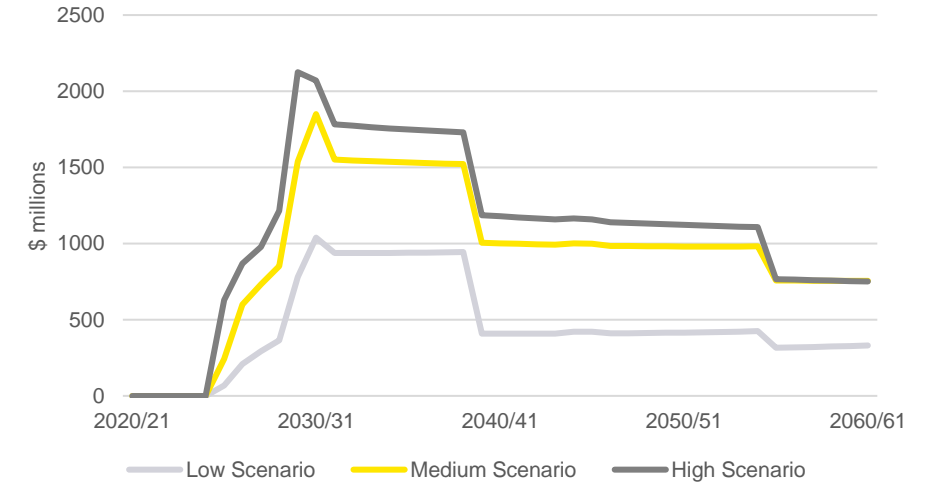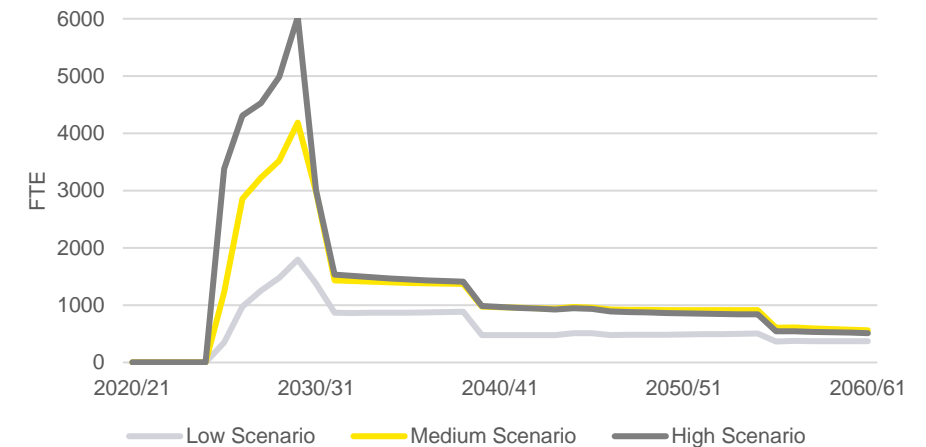**Figure 14 – GSP impact in Victoria**

Figure 15 – Employment impact in Victoria

EY

Environmental and social benefits

Environmental and social benefits overview

In addition to the significant economic benefits described, CarbonNet will provide a range of significant environmental and social benefits that are unable to be captured in the economic modelling, but nevertheless will have a significant impact for both the local community, and more broadly across Victoria. These benefits, outlined in the figure below, and discussed further on subsequent pages, are an important consideration when ultimately weighing up the costs and benefits of the project.

Enabling a low-emissions future

Carbon capture and storage (CCS) technologies are essential to achieving global climate goals and their role has become even more essential with the net-zero emissions ambition of the Victorian Government.

The CarbonNet project is expected to capture approximately **7M tonnes** of carbon dioxide emissions per annum (on average) over the life of the project.
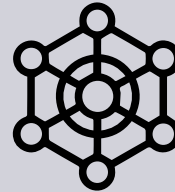
Industry development through clustering

CarbonNet will provide critical infrastructure for industry and both attract and encourage decarbonised industries to locate within the Gippsland region.

These new businesses to the region will provide flow-on benefits through agglomeration and clustering – including increased productivity and efficiency, increased transactions and interactions between firms, increased competition, innovation and knowledge creation.

Creating sustainable employment and educational opportunities

The attraction of industry activity to the region will help to create on-going employment opportunities for the local community, along with additional training and development opportunities.

These opportunities will stem mainly from the construction of CarbonNet, the operation of CarbonNet and the start-up and operation of enabled industries.

EY

Enabling a net-zero emissions future by capturing 7 million tonnes of CO_2 per annum

Carbon capture and storage (CCS) technologies are essential to achieving global climate goals and their role has become even more essential with the state's net-zero emissions ambition. Climate change remains one of the most complex challenges the world is facing and the sooner emissions can be reduced, the better the chance of fending off its worst impacts.

There are currently 26 commercial CCS facilities in operation, and a further 39 in various stages of development (GCCSI Annual Status Report 2020). CCS has versatile applications that can be used to decarbonise energy-intensive industries such as power, steel, cement, and fertiliser production. It can also reduce CO_2 emissions already in the air by delivering negative emissions through direct air capture (DAC) and bioenergy with CCS (BECCS).
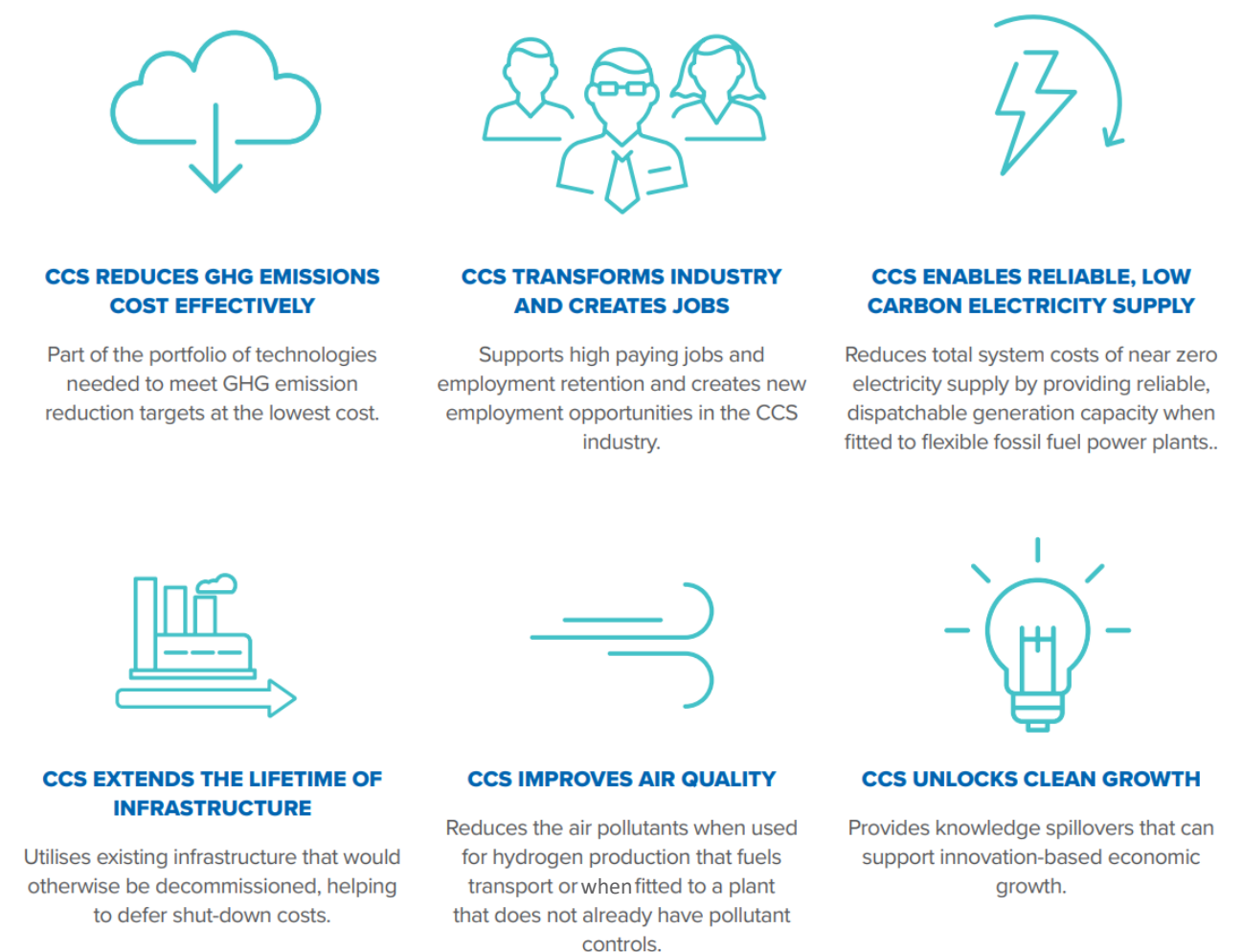
Emissions intensive industries contribute a relatively large share to economic output and are the backbone of many national economies. As a result of their capital intensity, the proportion of GDP they account for is much higher than their contribution to employment. For example, while the chemicals sector accounts for less than 0.5 per cent of total employment, it contributes 1.4 per cent of global GDP.

Investment in clean energy innovation, including CCS has multiple benefits for society, including supporting economic growth and addressing the externalities created by emissions and climate change (Figure 16).

Consistent with the Medium scenario modelled, the CarbonNet project is expected to capture approximately 7M tonnes of carbon dioxide emissions per annum (on average) over the life of the project.

By supporting the transformation of industry to a net zero economy, CCS can support a just transition for the local economies and communities that rely on emissions intensive industries for employment and income.

Figure 16 – Carbon capture and storage benefits

CCS REDUCES GHG EMISSIONS COST EFFECTIVELY

Part of the portfolio of technologies needed to meet GHG emission reduction targets at the lowest cost.

CCS TRANSFORMS INDUSTRY AND CREATES JOBS

Supports high paying jobs and employment retention and creates new employment opportunities in the CCS industry.

CCS ENABLES RELIABLE, LOW CARBON ELECTRICITY SUPPLY

Reduces total system costs of near zero electricity supply by providing reliable, dispatchable generation capacity when fitted to flexible fossil fuel power plants..

CCS EXTENDS THE LIFETIME OF INFRASTRUCTURE

Utilises existing infrastructure that would otherwise be decommissioned, helping to defer shut-down costs.

CCS IMPROVES AIR QUALITY

Reduces the air pollutants when used for hydrogen production that fuels transport or when fitted to a plant that does not already have pollutant controls.

CCS UNLOCKS CLEAN GROWTH

Provides knowledge spillovers that can support innovation-based economic growth.

Source: The Economy Wide Value Of Carbon Capture And Storage, Global CCS Institute 2020

EY

Industry development through clustering

The carbon capture and storage network that will be established through CarbonNet will provide critical infrastructure for industry and both attract and encourage decarbonised industries to locate within the Gippsland region. CarbonNet will therefore act as a catalyst which will enable the creation of a 'hub' for these industries. As more businesses locate and operate within close proximity to each other, further mutual benefits will arise as firms take advantage of natural economies of scale and synergies, with a 'hub' structure helping to make the development of infrastructure more cost-effective, while also promoting efficiencies from economies of scale, fostering innovation, and promoting sector coupling.

This 'hub' or 'cluster' model is a key component of Australia's National Hydrogen Strategy which sets a vision to create a clean, competitive and safe hydrogen industry, and to make hydrogen Australia's next energy export. On 1 February 2021, it was announced that the Gippsland Hydrogen Cluster, which has over 65 members, was awarded $250,000 in seed funding from NERA to aid the creation of an industry cluster that will foster cooperation, aid the development of supply chains and support the commercialisation of new technologies.

The cluster will also help to maximise economic benefits by ensuring Australian companies are well placed to supply new technology, products and services to Australia's hydrogen industry and export markets. As shown in the following figure, there are a wide range of potential uses for hydrogen, and therefore the establishment of a Hydrogen Industry Cluster will make the development of supply chain infrastructure more cost effective by aggregating these various users of hydrogen into one area.

Following a similar model, it is expected that CarbonNet will provide significant benefits for firms through clustering in terms of :
- Common use infrastructure
- Increased productivity and efficiency through utilisation of Gippsland's unique knowledge assets, expertise and strength across the energy industry
- Greater transactions and interactions between firms, resulting in rapid diffusion of best practices
- Ongoing rivalry with similar firms resulting in strong incentives to improve and innovate
- Knowledge creation from the presence of suppliers and networks
- Lower start-up costs for new companies because of available skills, suppliers, etc.

Figure 17 – Potential uses of Hydrogen

Source: Commonwealth of Australia, Australia's National Hydrogen Strategy

EY

Creating sustainable employment and educational opportunities

One of the key benefits of CarbonNet is the creation and support of the employment opportunities for the Victorian economy. As outlined below, CarbonNet will help to create new jobs through four key streams, each of which has its own diverse range of required skills. These four key streams include:

- Construction of CarbonNet

- Construction of CCS enabled industries

- Operation of CarbonNet

- Operation of enabled industries

In addition to the employment opportunities created, the presence of CarbonNet is also anticipated to increase skills and knowledge in Victoria with the development of a coal to other (CTX) industry and the use of CCS technology. The presence of the proposed CTX industries in the Latrobe Valley provides comparatively greater opportunities for engineering students and professionals through the existence of real life problems to solve and the opportunity to work in a new and growing industry.

The attraction of skills to new industries will improve the knowledge base of engineers, scientists and researchers in Victoria, and by enhancing the skills and innovative capacity of Victoria, that is likely to create positive effects beyond those impacts already measured.

Construction of CarbonNet and enabled industries

The construction of CarbonNet will require a substantial construction workforce which will provide a significant number of jobs to local construction workers.

However, these jobs will be temporary, lasting only for the construction phase of the projects development.

Example of skills required:

- Labourers

- Plant and machinery operators

- Civil engineers

- Pipeline engineers

Operation of CarbonNet

CarbonNet will provide the capability to capture, transport and store carbon emissions within an integrated network.

The operation of CarbonNet will require a relatively diverse range of skills, with the jobs created to be long-lived, lasting for the duration of the capture plants operation.

Example of skills required:

- Specialist engineers (e.g. chemical, mechanical, pipeline)

- Geoscientists

- Researchers
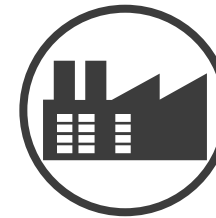
Operation of enabled industries

The deployment of CarbonNet will also enable high-value industries to continue to make a sustained contribution to economies by enabling them to make the transition to a net-zero emissions economy.

These industrial sectors are expected to co-locate in the region to access to infrastructure such as port and rail, and the necessary inputs to production such as energy resources, feedstocks and skilled workers.

Example of skills required:

- Industry dependent

EY

5

Case studies

EY

New developments in CCS
New projects in early development demonstrate further innovation and advancement.
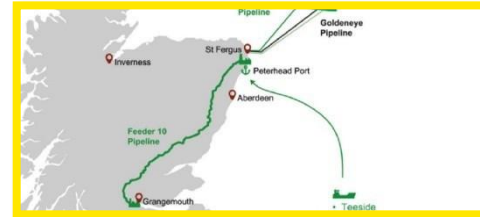
Northern Lights - Norway	Acorn CCS – UK	Zero Carbon Humber – UK

Northern Lights - Norway: *Part of a CCS chain comprising central storage of CO_2 from multiple sites in Norway and Northern Europe.*

Acorn CCS – UK: *Leveraging existing oil and gas pipeline infrastructure to deliver efficiencies and cost savings.*

Zero Carbon Humber – UK: *Large scale multi-site CCS to generate up to 100,000 jobs in the UK's largest cluster of industrial CO2 emitters.*

Country: Norway
Size: 1.5 MTPA
Industry: Cement/waste-to-energy
Stage of operation: Development

Country: The UK
Size: 0.2 MTPA (15 MTPA in the long run)
Industry: Gas/power generation
Stage of operation: Detailed engineering (development)

Country: The UK
Size: 0.9 MTPA (16 MTPA in the long run)
Industry: Power Hydrogen Chemicals
Stage of operation: Feasibility study

The Northern Lights project is part of the Norwegian full-scale CCS project. The full-scale project includes capture of CO_2 from industrial capture sources in the Oslo-fjord region (cement and waste-to-energy) and shipping of liquid CO_2 from these industrial capture sites to an onshore terminal on the Norwegian west coast. From there, the liquified CO_2 will be transported by pipeline to an offshore storage location subsea in the North Sea, for permanent storage.
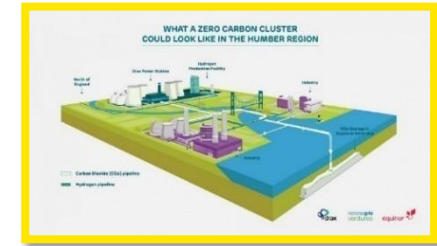
Acorn CCS will transport CO_2 from UK industry for permanent sequestration in saline formation in the North Sea. Acorn CCS is designed to be built quickly, taking advantage of existing oil and gas infrastructure and a well understood offshore CO_2 storage site.

Through the Acorn Hydrogen project, North Sea natural gas would be reformed into clean hydrogen, with CO_2 emissions safely mitigated through the Acorn CCS infrastructure. Hydrogen would be used in transport applications, and in the gas grid to decarbonise heating in our homes and industries.

Zero Carbon Humber is a partnership to build the world's first net zero industrial cluster and decarbonise the North of England.

Zero Carbon Humber plans to capture carbon dioxide at scale from industry around the estuary via pipelines that transport the emissions to permanent storage in naturally occurring aquifers under the southern North Sea.

The anchor project for Zero Carbon Humber is the Equinor-led Hydrogen to Humber (H2H) Saltend, which will establish the world's largest hydrogen production plant with carbon capture at px Group's Saltend Chemicals Park.

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CCS projects around the world
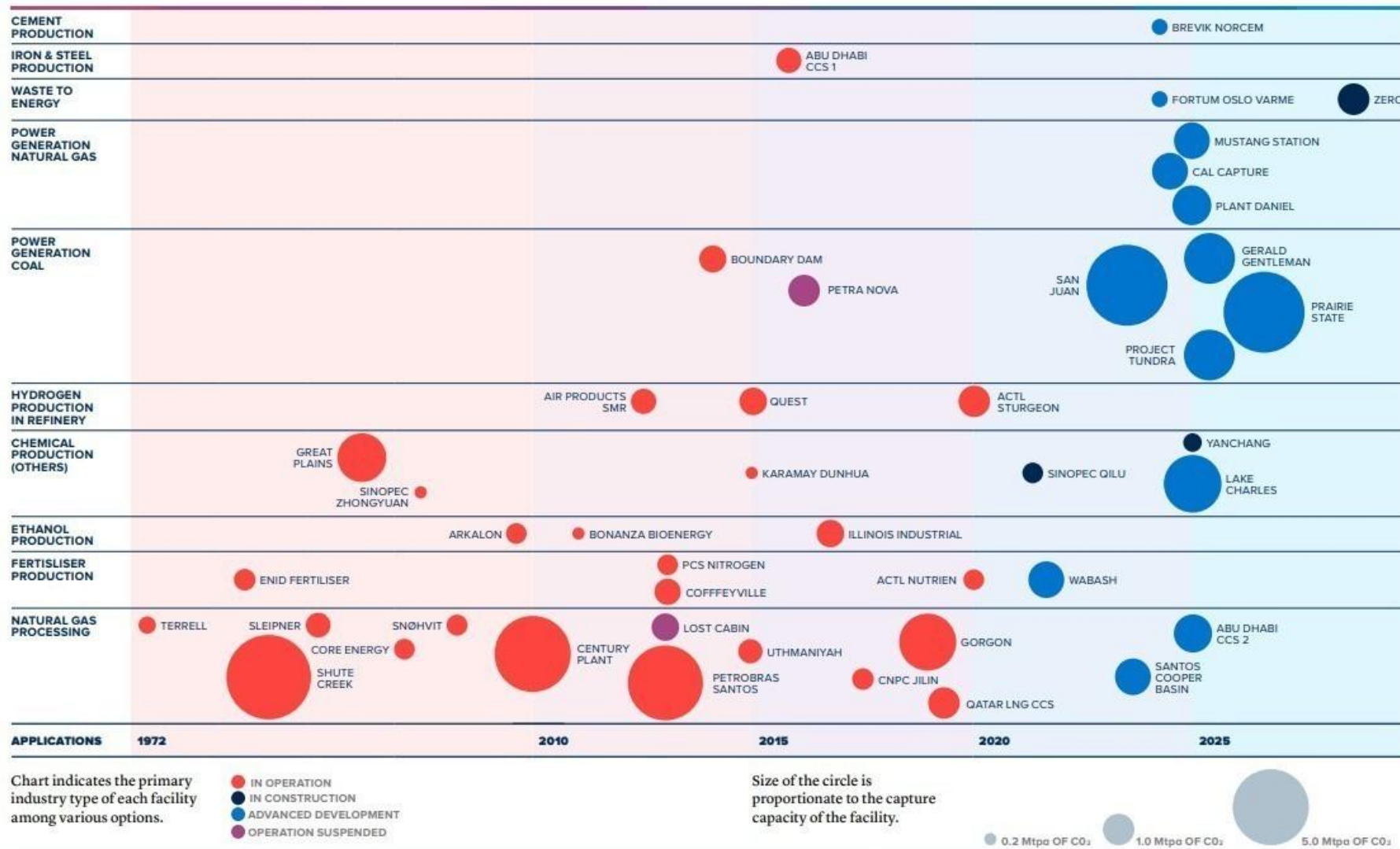
The Global CCS Institute (GCCSI) Annual Status Report 2020 shows that global capture and storage capacity has increased by 33% since 2019.

There are currently 65 commercial CCS facilities, with almost 40 million tonnes of carbon dioxide being captured annually from the 26 commercial CCS facilities currently in operation.

Of the other facilities:

► Two have suspended operations – one due to the economic downturn, the other due to fire

► Three are under construction

► 13 are in advanced development reaching front end engineering design (FEED)

► 21 are in early development.

CarbonNet is one of the largest and most advanced of these emerging projects.

Source: Global Status of CCS 2020, GCSSI, 2020

EY

Key CCS case studies

A range of existing CCS projects have been researched as case studies to better understand the potential economic, environmental and social benefits of CCS in Victoria.

These example projects demonstrate key impacts, considerations and lessons applicable to the CarbonNet context.

Initiatives were selected according to the following considerations:

Stage of development: Projects that are in operation and in advanced development are a more accurate and reliable comparison with available data on social, economic and environmental impacts.

Size: Projects of a similar annual storage capacity (1-5 million tonnes per annum) to CarbonNet were prioritised.

Industry: Case studies selected focus on the hydrogen production, fertiliser production and power generation industries.

Age: Given rapid pace of technological advancements made in CCS technology and infrastructure, newer projects are more likely to reflect similar conditions and impacts as CarbonNet and have been selected for comparison.

Sleipner – Norway, North Sea

The world's first commercial CO_2 storage project.

Country: Norway, North Sea

Size: 0.9 MTPA

Industry: Gas Processing

Stage of operation: Operation

Porthos - Netherlands

Innovating and future-proofing infrastructure to deliver economic benefits and industry efficiency.

Country: The Netherlands

Size: 2-2.5 MTPA

Industry: Various/Hydrogen

Stage of operation: Advanced development

ACTL Sturgeon – Canada

Building knowledge to stimulate innovation and investment attraction.

Country: Canada

Size: 1.8 MTPA (up to 15 MTPA in the long term)

Industry: Hydrogen/fertiliser

Stage of operation: Operation

Wabash - USA
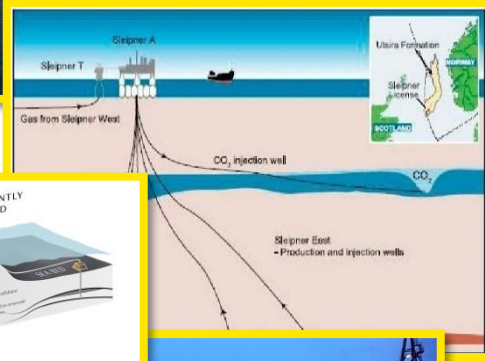
Producing affordable and competitive low-carbon products.

Country: USA

Size: 1.5 – 1.75 MTPA

Industry: fertiliser

Stage of operation: Advanced development

EY

Sleipner – Norway, North Sea
The world's first large scale commercial CO_2 capture and storage project.

0.9 MTPA	**Gas** Industry	**Operation** Stage	**$100m** (1996) Investment	**17mt** Captured and stored so far

Sleipner is a worldwide pioneer of CCS as the world's first industrial-scale CCS project for the purpose of carbon emission abatement. Since 1996, Sleipner has captured over 17 million tonnes of CO_2 from natural gas production for storage in an offshore aquifer more than 800 metres below the seabed (Utsira formation).

Social impacts

Developing research and information sharing
As a global pioneer in CCS, Sleipner has been invaluable in sharing information and experience with research networks and institutions globally. Knowledge from Sleipner has demonstrated the feasibility of safe long-term storage of CO_2 and contributed significantly to worldwide advancement and confidence in CCS.

Environmental impacts

Storage monitoring programme
Sleipner has employed a comprehensive monitoring programme to ensure secure long-term storage, prevent negative environmental impacts and improve storage technologies for wider deployment of safe CO_2 storage.

Safe containment
The geological formation of the Utsira sandstone (Sleipner storage site) is an extensive and highly porous sandstone filled with saltwater, preventing any seepage into the atmosphere or local environment.

Economic impacts

Carbon tax
Norway has had carbon taxes since 1991. Based on indicative tax rates, carbon capture and storage at Sleipner has saved an annual cost of 481 million NOK.

Improving competitiveness of gas industry jobs
As the larger of Norway's two CCS projects, Sleipner contributes significantly to the increased long term competitiveness of gas industry jobs. Sleipner represents a substantial portion of the estimated 10,000 people that will be directly employed in the Norwegian CCS industry in 2050.
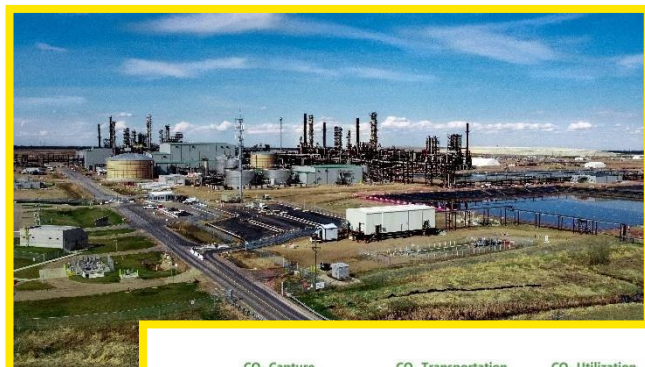
Company: Equinor   **Regions**: Norwegian North Sea   **Future expansion**: 1.2MTPA

EY

ACTL – Canada
Building knowledge to stimulate innovation and investment attraction.

1.8-14.6 MTPA

Hydrogen/fertiliser Industries

Operation Stage

$1 billion Investment

1,000+ Total jobs

Alberta Carbon Trunk Line (ACTL) captures CO_2 at the North West Redwater Partnership Sturgeon Refinery and Nutrien's Redwater fertiliser Facility. The CO_2 is safely transported to mature oil fields in Central Alberta for use in enhanced oil recovery (EOR) before permanent storage. ACTL has been in operation since June 2020.

Social impacts

Knowledge building and innovation
ACTL is building and sharing innovations and advancements in knowledge. The project provides technical reports to the Alberta Energy Regulator in a collaborative approach to promote education and further development and make CCS technologies more accessible.

Community engagement
ACTL has received widespread local support due to extensive local stakeholder engagement including information campaigns, personal consultations and public open houses.

Environmental impacts

Producing low carbon oil
Carbon captured by ACTL enables EOR that produces 60 per cent lower emissions per barrel than conventionally produced oil.

Enhanced safety
ACTL stores CO_2 in reservoirs which previously held oil and gas for tens of millions of years, ensuring fresh water aquifers and drinking water sources remain undisturbed and uncontaminated.

Economic impacts

Attracting investment and galvanising new industry
The certainty provided by ACTL's carbon price will attract private investment for new CCS projects. The presence of CCS infrastructure in the local area will also galvanise new industrial facilities taking advantage of efficiencies produced by the CCS hub.

Economic revitalisation of Central Alberta
The ACTL site as well as EOR industry activity generated by the captured CO_2 has the potential to produce thousands of jobs, representing a significant economic revitalisation for the local region.

Companies: NWR, Nutrien **Region**: Alberta Industrial Heartland (AIH) **Future expansion**: 14.6 MTPA

EY

Porthos – The Netherlands

Innovating and future-proofing infrastructure to deliver economic benefits and industry efficiency.

2.5 MTPA	**Hydrogen** Industry	**Advanced Development** Stage	**€500m** Investment	**1,200** Construction jobs

Porthos (Port of Rotterdam CO_2 Transport Hub and Offshore Storage) is a hybrid industry CCUS project in which CO_2 will be transported from various industries in the Port of Rotterdam and used in greenhouse industry or stored in empty gas fields beneath the North Sea. Operation is expected to commence in 2023.

Social impacts

Industry innovations
Porthos enables usage of CO_2, facilitating innovative carbon usage in industries such as greenhouse horticulture, an innovation which enables plants to grow faster at a large scale.

Enhancing Rotterdam's regional profile
As a European Commission Project of Common Interest, Porthos represents a flagship energy infrastructure project that is significantly raising the profile of Rotterdam as a integral region to Dutch national climate objectives.

Limiting negative social impacts
Porthos is limiting negative impacts on communities with infrastructure located exclusively offshore and outside of built environments.

Environmental impacts

High impact industries
Porthos is focused on a range of high impact industries which have few or no sustainable alternatives such as oil refineries and the chemical sector. CCUS represents the most viable option for these sectors in building a sustainable pathway into the future.

Economic impacts

Open access and economic efficiencies
Porthos' pipeline infrastructure will be open access and future-proof, which will allow other companies to engage in cost-effective, viable CCUS activity in future. This shared infrastructure model creates economic efficiencies and avoids the need for subsequent pipeline construction in future.

Companies: ExxonMobil, Shell, Air Liquide, Air Products   **Region**: Rotterdam port region   **Future expansion**: 5 MTPA

EY

Wabash – USA
Producing affordable and competitive low-carbon products.

1.75 MTPA	**Fertiliser** Industry	**Advanced Development** Stage	**600** Construction jobs	**200** Permanent jobs

The Wabash CCS project will capture and sequester the Wabash plant's CO_2 emissions more than 2,000 metres below the surface into Mount Simon Sandstone, a saline sandstone aquifer. Operation is expected to commence in 2022.

Social impacts

Use of advanced seismic technology
Wabash is leveraging advanced 3D imaging technology to conduct thorough seismic surveys and models of all subsurface layers in the area, allowing the plant to avoid naturally occurring fault zones and ensuring local community safety.

Environmental impacts

Low carbon intensity ethanol
Wabash will not only limit the direct emissions from ammonia production but will also reduce the carbon intensity of ethanol subsequently fertilized using these ammonia products.

Innovations in sustainable fertiliser technology
Wabash is developing the world's first near zero carbon footprint ammonia fertiliser, an important innovation given that fertiliser plants represent approximately 2 per cent of CO_2 emissions globally.

Economic impacts

Affordable access to sustainable ammonia
Wabash is enabling the production of sustainable fertiliser in the form of low carbon ammonia. This makes sustainable ammonia more available allows farmers and industry users to access sustainable fertiliser at an affordable price.

Low carbon ethanol markets
Low carbon ethanol produced using Wabash's ammonia will receive a significantly lower carbon intensity rating, making it more competitive on the international market and creating the possibility of new carbon economies.

Local job creation
Wabash is projected to create 600 construction jobs and 120 permanent jobs, representing a significant employment opportunity for local Vigo County.

Company: Wabash Valley Resources   **Region**: Terre Haute, Indiana   **Future expansion**: 18 MTPA

EY

Appendices

EY

Appendix A - CGE modelling framework

Computable General Equilibrium (CGE) modelling is used to measure the flow-on effects of changes in the economy. Such changes can originate from government policies, macroeconomic trends, or industrial activities. The impact of constructing and operating the carbon capture and storage site effects key industries in the regions. CGE modelling brings together diverse elements of the economy in a single database constrained by economic and behavioural equations. A depiction of some of these elements is given below. This approach recognises and quantifies the effects on unique industries, States and Territories, commodity flows, prices, and other variables. A summary of the CGE modelling approach is presented in the methodology section.

The following list of steps represents a high-level overview of the operations performed to develop the time-series database which underpins the Baseline and Scenario estimates .

1. Source data (ABS industry output, employment, GTAP10 database) collated and transformed for CGE modelling

2. Baseline forecast prepared including GRP and industry output forecasts for foundation of CGE (exogenous / fixed variables)

3. Policy shocks applied over baseline to model the GRP, employment and output effects of the three scenarios (outlined in the next slide)

4. Flow-on effects of scenario shocks to other regions and industries examined for coherence with economic theory

5. Final outputs from CGE for all industries and regions applied to baseline levels and compared

6. Modelling results collated and presented in year-on-year (levels) format

EY
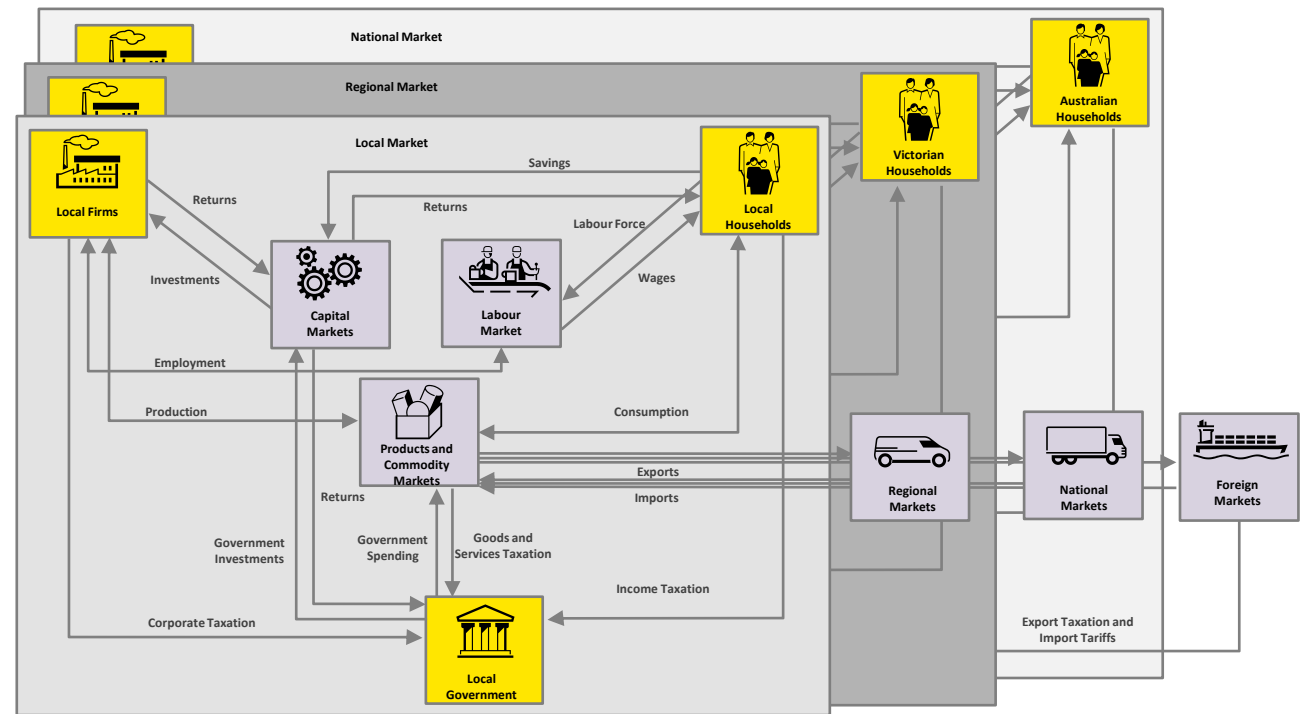
Appendix B - Dynamics of EYGEM

EYGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. This has two main advantages. First, dynamics allows a richer specification of the model in that issues such as debt accumulation (which facilitates the ability to model international capital flows) and labour market dynamics are able to be modelled in a more sophisticated manner. Second, scenario analysis using a model such as EYGEM can be greatly enhanced by the ability to alter the baseline, or reference case, to account for key developments or uncertainties.

The model is then used to project the relationship between variables under different scenarios, or states, over a pre-defined period. This is illustrated in Figure 11, where a reference case of 'baseline' forms the basis of the analysis undertaken by EYGEM. The model is solved year-by-year from time 0 which reflects the base year of the model (2020) to a predetermined end year (in this case 2050).

The 'Variable' represented in the figure could be one of the hundreds or thousands represented in the model ranging from macroeconomic indicators such as real GDP to sectoral variables such as the exports of iron and steel from Australia. In the figure, the percentage changed in the variables have been converted to an index(= 1.0 in 2020) and is projected to increase by 2050.

Set against this baseline, in Figure 11, is a 'Policy' scenario. This scenario represents the impacts of a policy change or different assumptions about economic development that results in a new projection of the path of the variable over the simulation time period. The impacts of the policy/assumption change are reflected in the differences in the variable at time T. It is important to note that the differences between the baseline and policy scenario are tracked over the entire timeframe of the simulation.

Figure 11 – Dynamic Simulation using EYGEM (Example only)
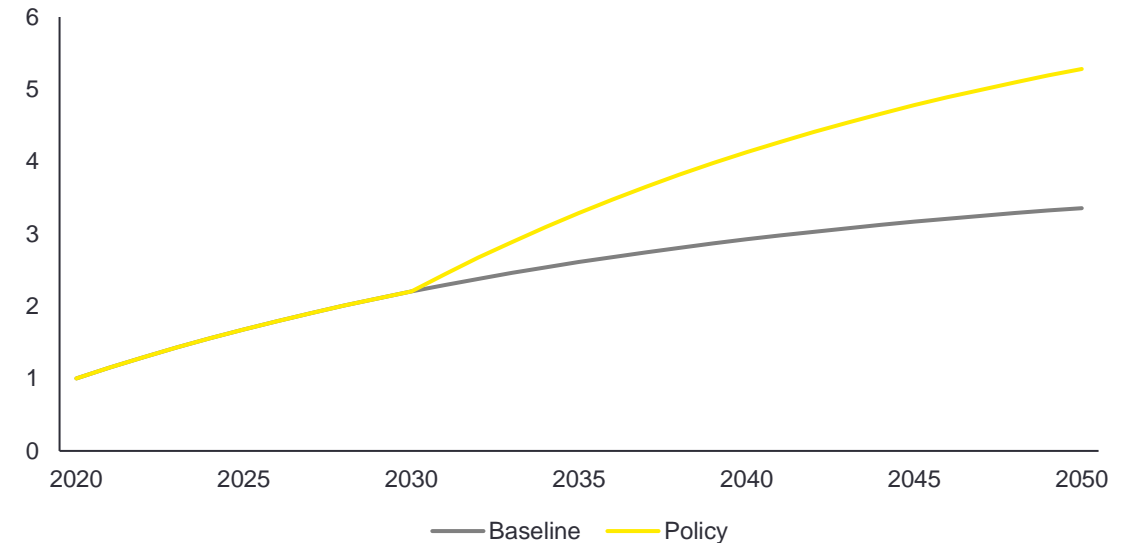
Appendix C – Key CGE Modelling Assumptions

EYGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

► The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).

► Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas utility function.

► Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.

► Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a Cobb-Douglas utility function.

► All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.

► Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.

► Producers are cost minimisers, and in doing so choose between domestic, imported and interstate intermediate inputs via a CRESH production function.

► Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return.

► Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

► Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).

► For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But in relative terms imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.

► **Industries:** There are 19 industries included in the model.

► **Regions:** There are 5 regions in the model, these include Latrobe region, the Wellington region, the rest of Victoria (RoVIC), the rest of Australia (RoA) and the rest of World (RoW)

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Appendix D – Employment by industry impacts

Employment impacts – Latrobe/Wellington

Construction phase	Low scenario	Medium scenario	High scenario
Gas	26	42	55
Chemicals	13	27	96
Construction	747	1492	2780
Trade	225	503	933
Processed Food	-27	-50	-90
Manufacturing	-51	-226	-513
Other industries	89	175	223
Total jobs created (annual)	1022	1963	3484

Operational phase	Low scenario	Medium scenario	High scenario
Gas	42	104	119
Chemicals	38	80	204
Construction	30	81	159
Trade	142	289	257
Processed Food	-9	-15	-21
Manufacturing	127	42	-22
Other industries	315	517	417
Total jobs created (annual)	685	1098	1113

Employment impacts – Victoria

Construction phase	Low scenario	Medium scenario	High scenario
Gas	26	43	55
Chemicals	-30	-58	-34
Construction	1192	2623	4508
Trade	444	938	1552
Processed Food	-123	-241	-401
Manufacturing	-30	-58	-34
Other industries	-231	-540	-1227
Total jobs created (annual)	1248	2707	4419

Operational phase	Low scenario	Medium scenario	High scenario
Gas	48	104	127
Chemicals	3	17	84
Construction	80	146	195
Trade	315	520	465
Processed Food	-42	-57	-68
Manufacturing	-140	-320	-403
Other industries	460	766	731
Total jobs created (annual)	724	1176	1131

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