SOLENT LOCAL INDUSTRIAL DECARBONISATION PLAN (SOLENT LIDP)

TRANSITIONING PATHWAYS VERSION 1

JANUARY 2025

THE SOLENT CLUSTER

CONTENTS

1. FOREWORD

As a collaboration involving a wide and diverse group of cross-sector organisations, The Solent Cluster was perfectly positioned to bid to the Government's Local Industrial Decarbonisation Plan (LIDP) competition in partnership with Innovate UK (IUK).

Announced in early 2024, The Solent Cluster was one of 13 projects to win funding, and this grant was complemented by funding from project partners to bring the project total to over £1 million.

The project – comprised of a team from industry and academia – set out to evaluate public perception on decarbonisation, and to identify barriers that need to be overcome and opportunities on which to expand to successfully decarbonise the Solent region. We knew we could demonstrate how an area such as this has the potential to make a truly significant contribution to the overall decarbonisation of the UK, and how the transition to a lower carbon economy is a once-in-a-generation opportunity to drive local economic growth and skilled jobs in our local communities.

Over the past year, The Solent Cluster LIDP project partners have explored, modelled, consulted and challenged. They have worked to understand the evolution of emissions, conducted feasibility studies, modelled scenarios, considered market, policy and regulatory opportunities and difficulties. They have looked at their own activities, at the economic benefits and the case for investment; and they've engaged with over 100 partners locally across industry, academia, local government and community groups to gain a better understanding of how to win the public support that is needed for change on this scale.

This Transitioning Pathways Report sets out how smaller industrial manufacturing businesses can accelerate their journey to Net Zero through sharing knowledge and skills and wide-ranging dissemination.

There are certainly many challenges to be overcome as we move to a lower carbon future, and the report shows the enormous potential that exists in the Solent's innovation and collaboration ecosystem which could see the wider South of England become a leading area for low carbon investment.

Anne-Marie Mountifield
Chair, The Solent Cluster

2. EXECUTIVE SUMMARY

The Solent region is one of the largest industrial regions in the UK, centred around the Solent waterway and the port cities of Portsmouth and Southampton. The Solent is a significant economic centre, supporting a £31 billion local economy and over 500,000 jobs.

This report sets out decarbonisation progress within the region and provides **forward-looking ideas as to how industrial decarbonisation of the Solent region may be achieved**. Annual Scope 1 emissions within the region currently exceed 5 $MtCO_2e$ and, under a business-as-usual scenario, only a 2% reduction in emissions is forecast by 2050. In the absence of new decarbonisation initiatives, the Solent region could be poised to remain a high-emitting industrial cluster. Decarbonisation of industry in the Solent region is therefore essential to meet UK Government Net Zero and Industrial Decarbonisation targets, and represents **a once-in-a-generation opportunity**, to drive local economic growth and employment opportunities.

This is the Solent LIDP Report Version 1. It seeks to set out the ambition of the Solent region but also provides a range of scenarios that require further feasibility studies.

Modelling of decarbonisation opportunities in this work suggests that **deep decarbonisation of industry can be achieved in the Solent region**, with potential industrial emission reductions of over 99% by 2050. This could see total abatement of over 90 million tonnes of CO_2, compared to a baseline scenario. Achieving deep decarbonisation will require deployment of multiple technologies and major infrastructure, including **electricity network upgrading** (to support electrification), **low carbon hydrogen production and carbon capture**. The role of carbon capture is particularly critical, with major industries such as petrochemical production and energy from waste facilities lacking alternative opportunities to reduce emissions. This infrastructure could unlock further opportunities for new energy transition projects, such as the production of sustainable aviation fuels and renewable methanol, for use at airports including Heathrow and Gatwick, alongside Portsmouth and Southampton ports.

Delivery of these infrastructure and decarbonisation projects will offer significant benefits to the Solent region and the wider UK, through emissions reductions, local investment, economic growth and the creation of high-quality green jobs. **However, realisation of these projects will also require significant action.** This must include policy support, local collaboration and transformative skills development in the region to navigate this journey.

This report concludes with a pathway towards the decarbonisation of the Solent region.

- **Near-term emissions reductions projects** can be developed at a number of sites, without reliance on extensive wider infrastructure. Energy efficiency measures and equipment upgrading may represent "no-regret" activities.
- **Major infrastructure and decarbonisation projects** will be critical at the highest emitting sites in the region. Collaboration with, and further support from, the Government for clusters outside of Track 1 and 2 can unlock these projects in the Solent region.
- **Further energy transition opportunities** may also be unlocked through infrastructure deployment and the Solent region's unique position as an existing industrial hub with connections to major ports and airports. Projects in renewable maritime fuels and sustainable aviation fuels could drive decarbonisation across other sectors and the wider UK, and provide further economic growth locally.

These projects will be underpinned by continued activity and collaboration between local industry, education, regional infrastructure operators, academia, the public sector, and The Solent Cluster. Priorities in the region will be to build local skills in industries of the future and support local workforces. Learnings must be shared as decarbonisation projects develop and engage with local stakeholders and the wider public to continue to build support and progress towards a decarbonised future. The central leadership role of The Solent Cluster will be critical to convening the sector, providing a central coordination of activity and advocacy.

3. INTRODUCTION

3.1 COMPETITION OVERVIEW

The Solent Local Industrial Decarbonisation Plan (Solent LIDP) is a comprehensive plan for industrial emissions reduction in the Solent region – one of the UK's largest and most strategically significant industrial regions.

The Local Industrial Decarbonisation Plan (LIDP) competition was launched in 2023 by the Department for Energy Security and Net Zero (DESNZ) and Innovate UK. The competition provides support for industrial regions not included within the Industrial Decarbonisation Challenge to develop plans to reduce their emissions and avoid carbon leakage. Organisations were invited to come together to form local "clusters" of closely located industrial businesses and other stakeholders. The competition has provided grant funding to 13 projects, to build collaborative plans to achieve deep decarbonisation locally. [1, 2]

The Solent region is the largest grouping of regional emissions outside of the six industrial clusters supported within the Industrial Decarbonisation Challenge, and a hub for a range of crucial industries, including manufacturing, refining, maritime, defence & aerospace engineering, chemical production, and power generation. Products and fuels from the Solent region are used across the UK and, through major ports at Southampton and Portsmouth, the region represents a key hub for trade with global markets and an opportunity for maritime decarbonisation.[3, 4]

The Solent LIDP project has been led by The Solent Cluster, supported by a consortium with expertise from across the Solent region.[5] This plan lays the foundations for the Solent region to achieve deep industrial emissions reductions by 2050, green job creation and economic opportunities both within the region and for the UK more widely.

3.2 INTRODUCTION TO THE SOLENT REGION

The Solent region is one of the largest industrial areas in the UK, centred around the Solent waterway and the port cities of Portsmouth and Southampton, but also encompassing the Isle of Wight, M27 corridor, and the New Forest.

The Solent region is a key, strategically located economic hub, supporting a £31 billion economy and 42,000 businesses.[6] With a rich maritime history and seeing over 200,000 large vessel movements and £77.5 billion in goods imports and exports each year, the ports of the region are a vital gateway for trade between the UK and European and global markets.[5, 7] The Port of Southampton is a key stopping point along the world's busiest shipping route between Rotterdam and Shanghai, and the Solent region was also awarded "Freeport" status in 2021. The region is well-connected to elsewhere in the UK through road, rail and other infrastructure, and internationally through proximity to Southampton, Gatwick and Heathrow airports.

Over 500,000 jobs are based in the Solent region and the area hosts major industries, including in the manufacturing, refining, chemical production, maritime, defence and aerospace engineering and power generation sectors. The region is also well-placed in research, academia and innovation, with three major universities across Southampton and Portsmouth.

1 *"LIDP Competition: Winning Projects"*, DESNZ
2 *"Industrial Decarbonisation"*, UKRI
3 *"What is the Industrial Cluster mission?"*, BEIS
4 Although significant players in regional infrastructure, direct emissions from ports in the Solent region are not included in analysis in this report. Direct emissions data has not been available during this work, but understanding these and potential opportunities for future decarbonisation is a target for future work.
5 *"About"*, The Solent Cluster
6 *"Economic Outlook"*, Solent Local Enterprise Partnership
7 *"Ports"*, The Solent Forum

Often complemented by these institutions, the Solent region hosts a significant research and development (R&D) industry, with potential to continue to drive growth across multiple sectors.

A vision for a decarbonised Solent region

The Government has pledged for the UK to achieve Net Zero carbon emissions by 2050. The Solent industrial region represents one of the largest clusters of emissions in the UK, meaning significant decarbonisation in the region will be required to align with this target. This Solent LIDP seeks to identify key steps towards achieving these emissions reductions, while maximising co-benefits in the region. The Solent Cluster also seeks to become **a leading centre for low carbon investment that will grow the regional economy, protect skilled jobs, and create new employment opportunities in the energy technologies and industries of tomorrow**.

As part of this vision, the Solent region is well-positioned to drive benefits and unlock opportunities locally and to the wider UK:

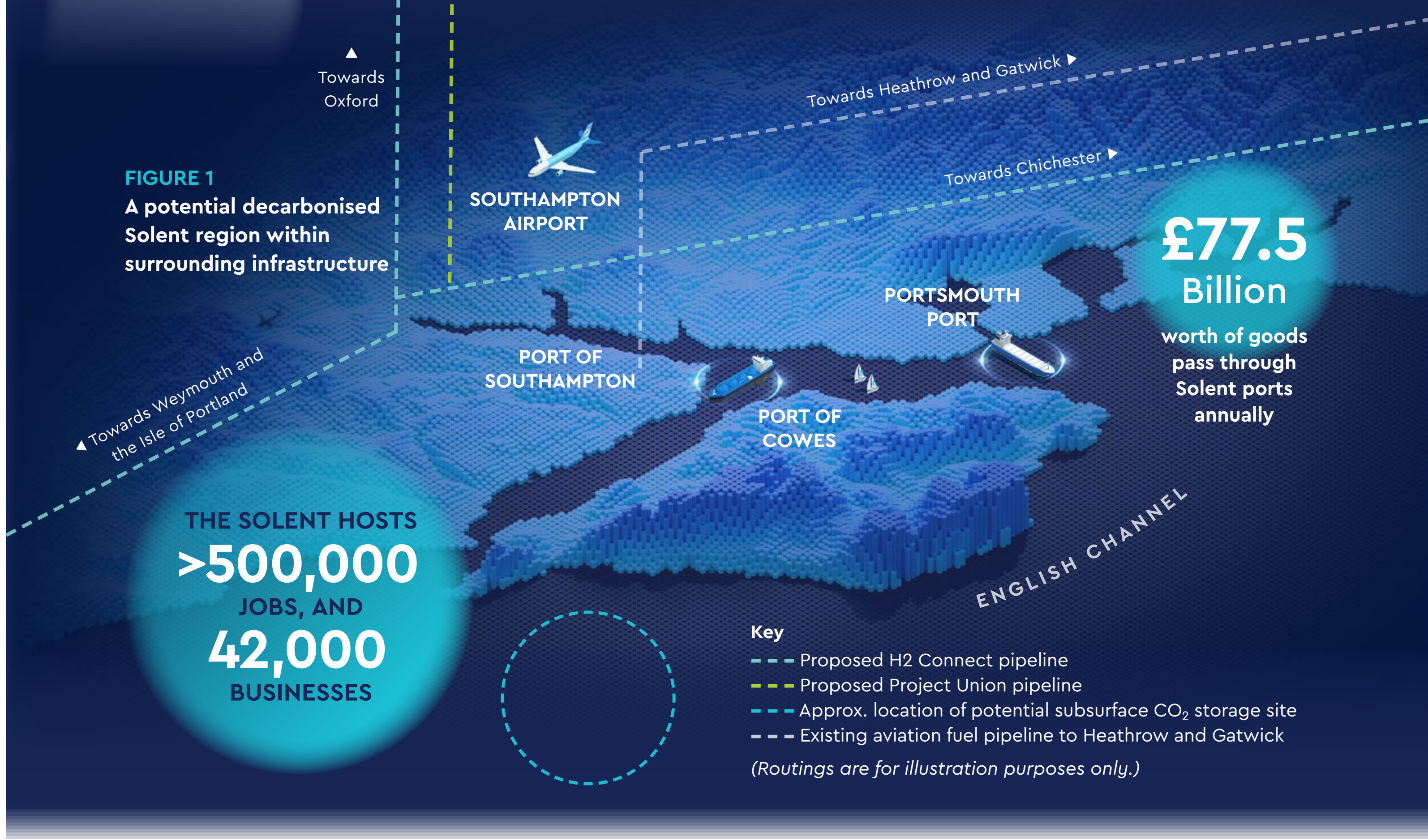
- Critical sectors to a modern UK industrial economy, including key energy and chemical products, advanced manufacturing and a centre for maritime, defence and aerospace engineering are all significant in the Solent region. Decarbonisation of these facilities could develop local industry into a hub for green innovation, manufacturing and products vital to a Net Zero transition.
- Existing port infrastructure alongside road and rail transport links also positions the region as a future hub for decarbonised aviation and maritime industries within the UK and could also enable shipping of captured CO_2.
- Further infrastructure to drive industrial decarbonisation will be required locally, potentially also opening up further opportunities to deliver green, low carbon fuels such as hydrogen for industry, renewable methanol for shipping and sustainable aviation fuels. These opportunities may connect into existing and other planned infrastructure such as fuel supply to major airports and shipping ports, hydrogen transmission networks (e.g. Project Union and H2 Connect) and major hydrogen storage (e.g. at the Isle of Portland).
- The electrification of small and medium industrials in the region can provide an opportunity for short–medium term emissions reductions.

3.3 WIDER POLICY CONTEXT

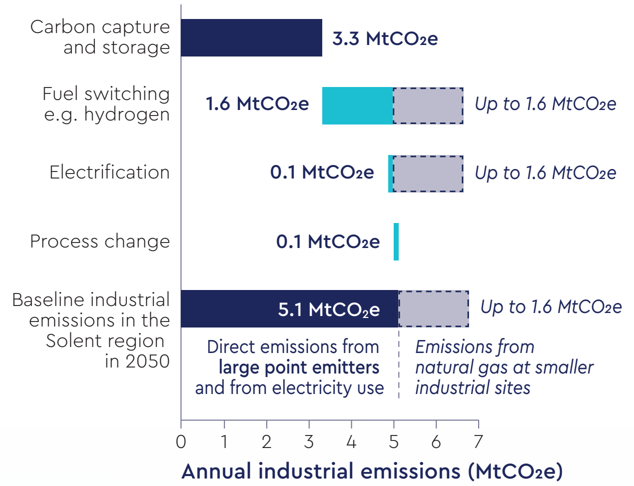
The UK Government has pledged to achieve Net Zero greenhouse gas (GHG) emissions by 2050, and committed to reducing GHG emissions in 2030 by 68%, compared to 1990 levels.[8] The Climate Change Committee (CCC) provided a progress report to Parliament in July 2024, highlighting the strong progress made to date in emissions reductions but also that urgent action is still required.[9] The CCC assesses that only a third of emissions reductions required to achieve the 2030 target are currently covered by credible plans, therefore action is needed across all sectors to meet these targets. Decarbonising hard to abate sectors such as industry, maritime and aviation are all major barriers to meeting 2050 targets and they are all represented in the Solent region. The UK has an interim target to reduce industrial emissions by two-thirds by 2035, with hydrogen, electrification and CCS key decarbonisation pillars. Announced UK-wide government targets which support decarbonisation of industry and other sectors located in the Solent include focus across hydrogen, carbon capture and storage, clean power and sustainable aviation fuel, as shown in Figure 2.

8 *"The UK's plans and progress to reach Net Zero by 2050"*, House of Commons Library
9 *"2024 Progress Report to Parliament"*, Climate Change Committee

FIGURE 1
A potential decarbonised Solent region within surrounding infrastructure



Potential emissions reduction by technology in a "deep decarbonisation" scenario in 2050



Under a baseline trajectory, industrial emissions from major point emitters and industrial electricity use in the Solent region could be as high as **5.1 $MtCO_2e$/year by 2050**. System modelling suggests that these emissions can be almost completely abated using a range of technologies.

Additional emissions through **natural gas consumption at smaller industrial emitters may contribute an additional 1.6 $MtCO_2e$/year**. Abatement opportunities are likely to be across hydrogen fuel switching and electrification.

The full methodology used to estimate these smaller site emissions is included in Appendix B.

KEY NOTES

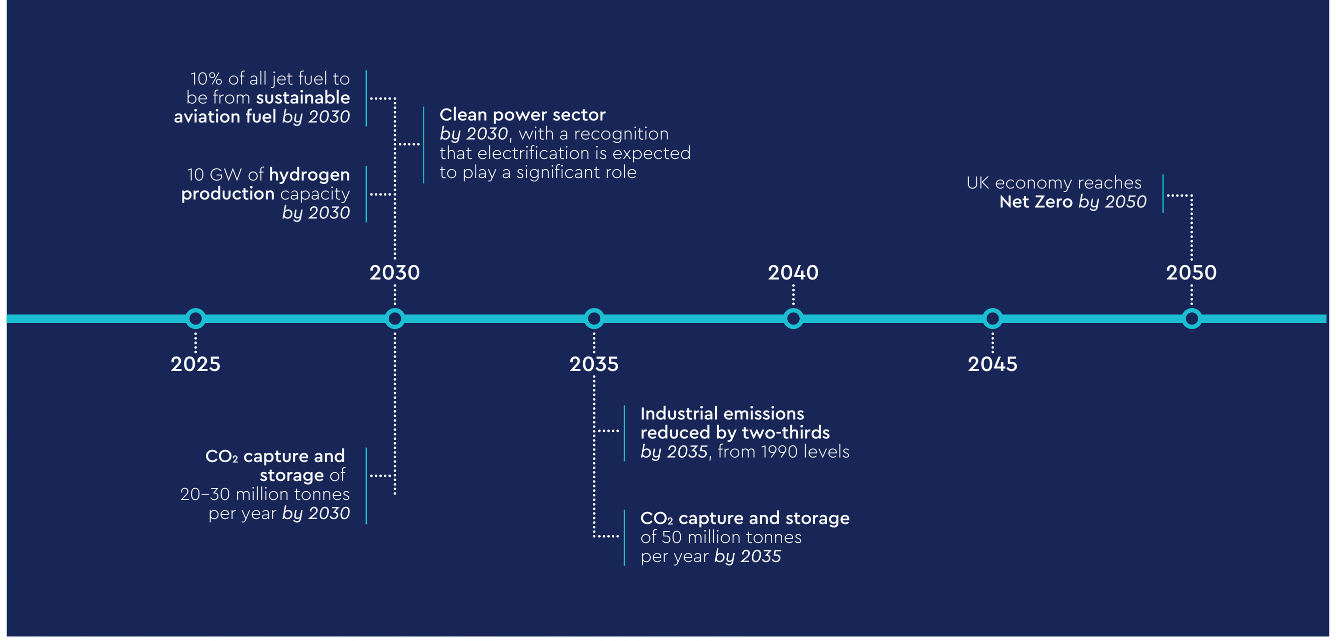
The University of Southampton is leading research funded by the National Industrial Decarbonisation Research and Innovation Centre (IDRIC) on **bioenergy with carbon capture and storage (BECCS)** and a model for optimising CO_2 shipping and port infrastructure and storage through the **CO_2 ports to pipeline project**.

Low carbon fuels could be produced in the region for local industry in addition to other sectors. This could include **methanol**, which can be produced from hydrogen and carbon dioxide, and could help reduce maritime transport.

UKEn intends to develop 2 billion cubic metres of hydrogen storage on the Isle of Portland by 2035, providing up to 20% of the UK's hydrogen storage needs.

CO_2 can potentially be stored under the sea, in saline aquifers, such as those in the English Channel.

FIGURE 2: Timeline of key UK Government targets around industrial and wider decarbonisation



Local and national policy has a major role in supporting these targets, alongside the renewable energy mix, deployment of technology, and future transport systems. Under the previous government, industrial decarbonisation efforts were driven through a cluster-led approach. The Government's Industrial Clusters mission in 2021 set the ambition to establish the world's first Net Zero Industrial Cluster by 2040, with projects supported by the Industrial Decarbonisation Challenge Fund. Their ambition was to enable the formation of collaborative industrial clusters through which the biggest GHG emitters would work in collaboration to plan and deploy low-carbon technologies such as carbon capture and storage or hydrogen generation, which would subsequently enable decarbonisation of a range of energy-intensive industries that are geographically co-located. Six industrial clusters across the UK have been previously selected to develop Industrial Decarbonisation Challenge cluster plans, with these currently emitting between 0.5 and 9 $MtCO_2e$ per year.[10,11]

The transition to cleaner, decarbonised industrial regions offers numerous co-benefits, particularly when viewed at a local level. For the Solent region, this includes job creation in existing and emerging sectors, and economic growth. Achieving these benefits requires action from the Government, local industrials and other stakeholders.

10 *"Enabling Net Zero: A Plan for UK Industrial Cluster Decarbonisation"*, UKRI
11 Emissions values are indicative, based upon point source emissions data in 2019 from the National Atmospheric Emissions Inventory.

4. KEY PARTNERS AND DEVELOPMENT OF THE DECARBONISATION PLAN

This Solent Local Industrial Decarbonisation Plan project has been led by The Solent Cluster – an initiative bringing together private and public sector organisations with academia and seeking to collaborate towards common aims of achieving lower carbon economic growth within the Solent region.

The Solent LIDP project has been delivered collaboratively alongside a diverse project team, all of which can play a role in the decarbonisation in the Solent region:

- Ada Mode
- Enoflex
- ExxonMobil
- GEO Specialty Chemicals
- StandardAero
- SSE Energy Solutions
- University of Southampton
- Veolia.

Engaging with local communities and businesses has also been central to project delivery. The Solent Cluster has held regular knowledge-sharing and networking sessions throughout the Solent LIDP work, seeking input from this wider audience and keeping this group informed of progress.

The project has also been supported by expertise and technical contributions from Blunomy and ERM.

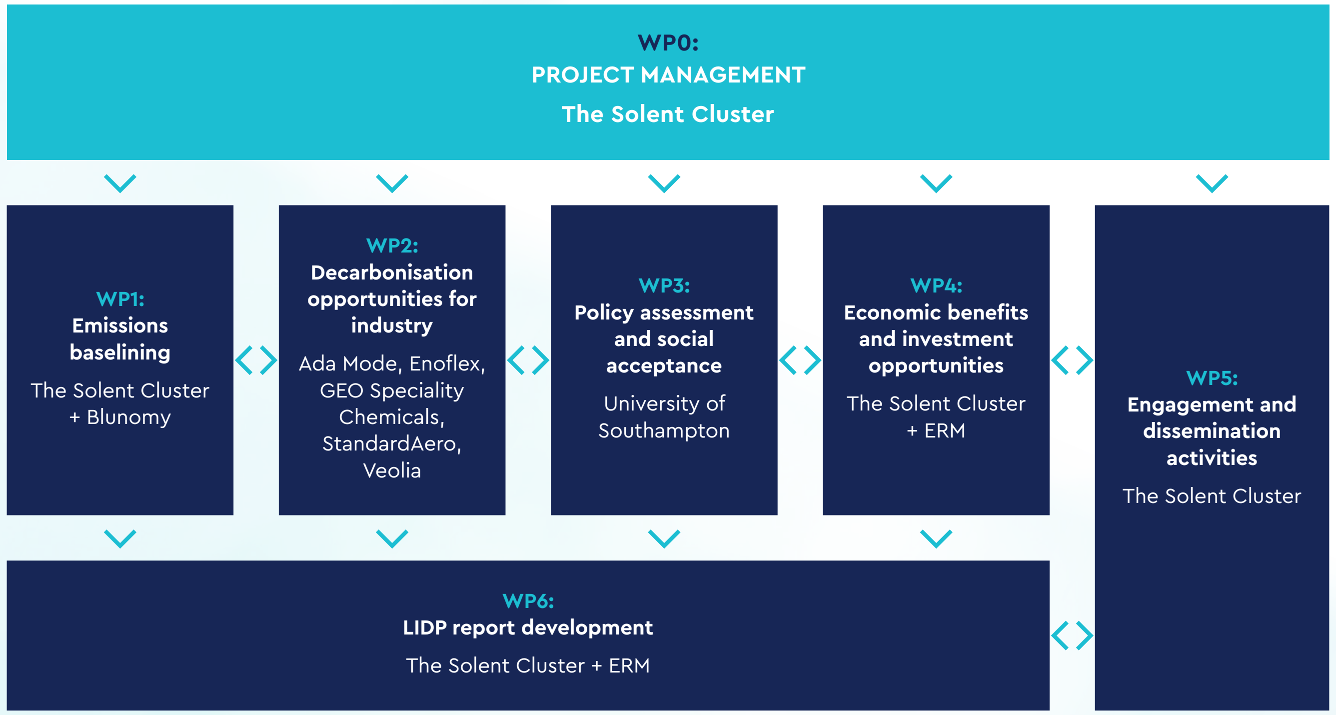
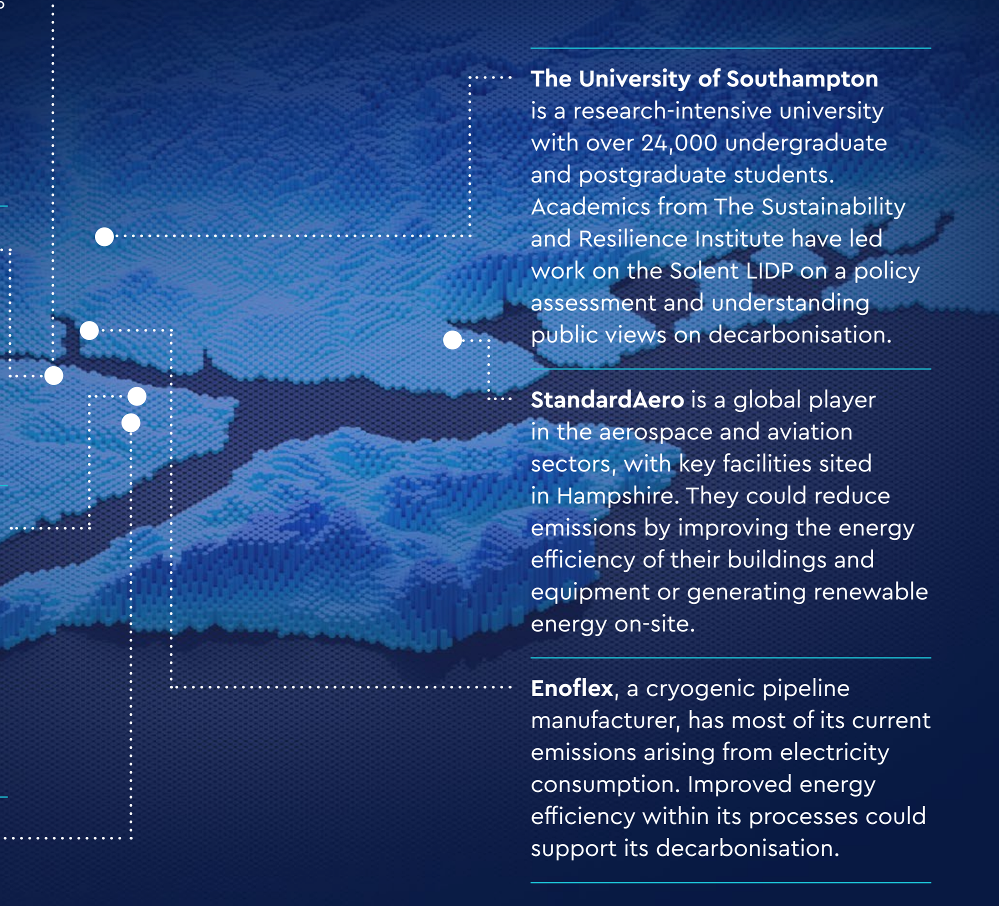


FIGURE 3: Project delivery team for the Solent LIDP

The Solent region is uniquely positioned as a major industrial hub, containing some of the largest emitting facilities in the UK, whilst being home to numerous small and medium-sized industrial sites, geographically spread across the region. The approach to producing the Solent LIDP reflects this accordingly, with the project team including businesses operating across the full extent of this scale.

The delivery approach has integrated both top-down analysis of the infrastructure and energy needs at the regional level, and a bottom-up consideration of how diverse industries can deliver emissions reductions and co-benefits at a local level. This report summarises many of the findings from more detailed reports undertaken by The Solent Cluster and project partners, which can be found at here.

FIGURE 4: Project team members in the delivery of the Solent LIDP
The Solent Cluster brings together private, public and non-governmental organisations who wish to collaborate to decarbonise the Solent region and beyond. The Solent Cluster is leading work on delivery of the Solent LIDP.



SSE Energy Solutions is an energy supplier to business delivering 100% renewable power to customers, including in the Solent region. It is providing technical and commercial expertise to partners across the LIDP project.

Veolia operates two energy recovery facilities, at Marchwood and Portsmouth, supplying electricity to close to 45,000 homes. Any captured CO_2 could be used in producing fuels like methanol.

GEO Specialty Chemicals operates a facility in Hythe, manufacturing a range of high purity specialty chemicals. A range of solutions are being explored to reduce site emissions, including improved equipment efficiency, and on-site renewable electricity generation.

ExxonMobil operates the Fawley Petrochemical complex, the largest integrated refinery and chemical complex in the UK. The site includes emissions-intensive processes, with opportunities to reduce emissions continuing to be explored.

The University of Southampton is a research-intensive university with over 24,000 undergraduate and postgraduate students. Academics from The Sustainability and Resilience Institute have led work on the Solent LIDP on a policy assessment and understanding public views on decarbonisation.

StandardAero is a global player in the aerospace and aviation sectors, with key facilities sited in Hampshire. They could reduce emissions by improving the energy efficiency of their buildings and equipment or generating renewable energy on-site.

Enoflex, a cryogenic pipeline manufacturer, has most of its current emissions arising from electricity consumption. Improved energy efficiency within its processes could support its decarbonisation.

5. DECARBONISING THE SOLENT REGION

5.1 CURRENT REGIONAL EMISSIONS

5.1.1 Where are we now?

The Solent region is a major industrial region, with a variety of critical industries including manufacturing, refining, maritime, defence & aerospace engineering, and chemical production, in addition to considerable power generation capacity. Annual emissions exceed 5 $MtCO_2e$, placing it among the largest emitting industrial regions in the UK, and contributing over 4% of all industrial emissions nationally.[12,13] Several major facilities are central to the historical industrial landscape in the region, providing employment locally and developing vital outputs for the wider UK economy, but remain emissions intensive.

ExxonMobil's **Fawley Petrochemical complex** is the largest integrated refinery and chemical complex in the UK. It has been central to the economy of the Solent region since its construction in 1951 and continues to employ over 2,500 staff and contractors at the site.[14] It is a strategic national asset for the UK and critical for the UK's energy security and resilience. The site processes crude oil, shipped into the terminal, before processing this into a wide range of products including energy products (such as petrol, diesel, jet fuel and LPG), lubricant oils and chemical products for use in a wide range of everyday products. The Fawley site is also home to many emissions-intensive processes, with boilers, furnaces and on-site electricity generation consuming significant amounts of energy and producing significant amounts of CO_2. Opportunities to reduce emissions at the complex continue to be explored.

The **Marchwood Power Station** is a natural gas-fired power station, operational since 2009 at Marchwood Industrial Park. With a generation capacity of 895 MW, sufficient to power close to one million homes, the site represents a key piece of infrastructure in the Solent region.[15] The station is one of the most efficient of its kind in the UK but remains a major source of emissions in the region.

Veolia operates two **energy recovery facilities** in the Solent region, at **Marchwood** and **Portsmouth**. The sites have been operational since 2004 and 2005 respectively. These facilities both process non-recyclable waste to produce and supply electricity. Between the two sites, sufficient power is generated for close to 45,000 homes, highlighting the role that these facilities play in both regional waste management and power generation.

In addition to these major facilities which contribute a large portion of regional industrial emissions, a number of other facilities are also sited around the Solent region, contributing to a diverse industrial economy. Despite many of these facilities falling below emissions reporting thresholds, emission reductions at these are also critical in reducing regional emissions and driving green economic growth.[16] Key operators of smaller sites in the Solent region include:

- **Marine, defence and aerospace engineering**, through companies such as Airbus, Astrium, BAE Systems, GE Aviation Systems, GKN Aerospace, Qinetiq, StandardAero and Wight Shipyard.

12 As a proportion of provisional 2023 total emissions figures for "electricity supply", "fuel supply" and "industry" across the UK. Data from "*Provisional UK greenhouse gas emissions national statistics 2023*", DESNZ

13 The Solent region is defined to include the eight local authority areas of Eastleigh, Fareham, Gosport, Havant, Isle of Wight, New Forest, Portsmouth and Southampton.

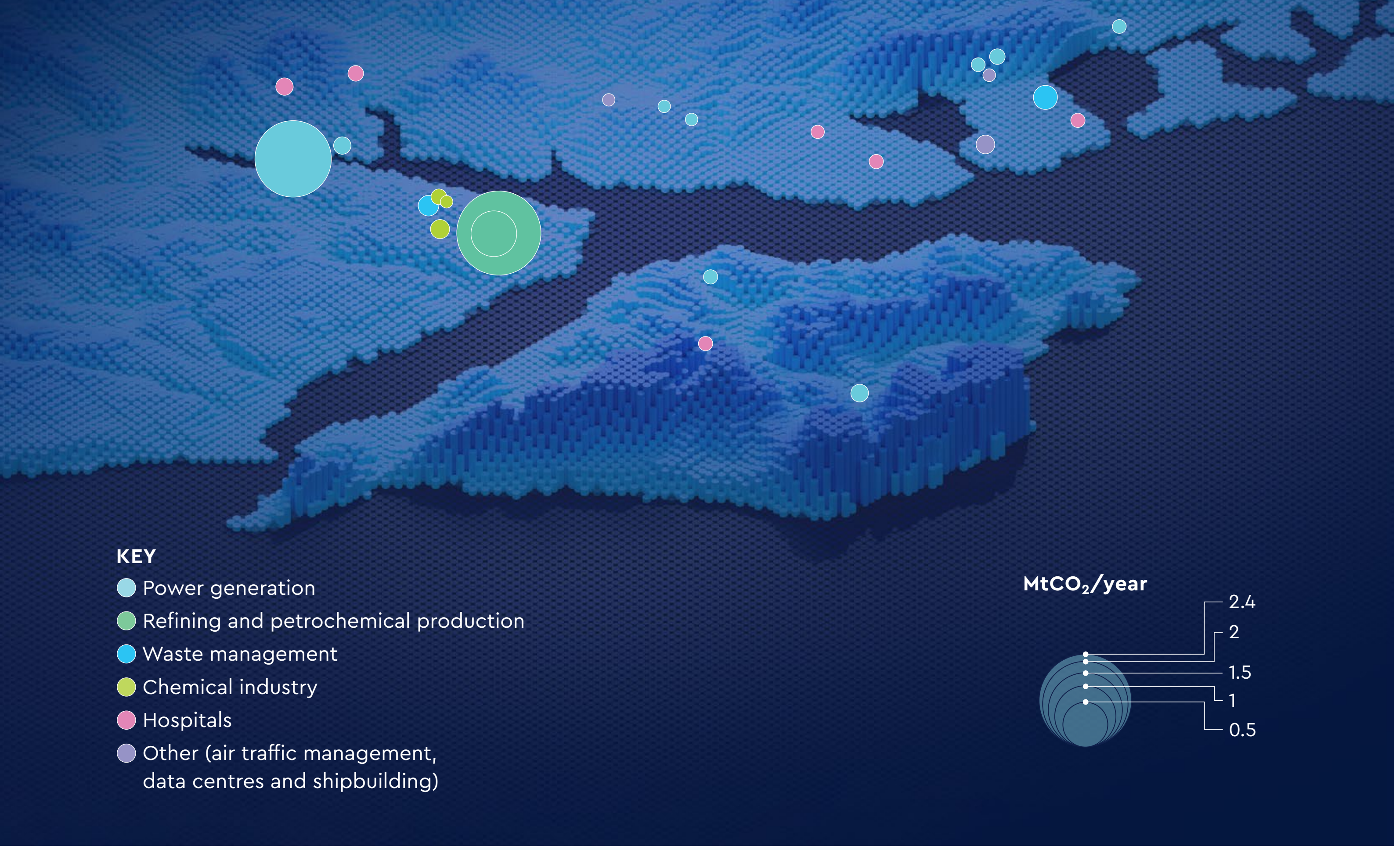
14 "*Fawley Operations*", ExxonMobil

15 "*Marchwood Power*", Marchwood Power Limited

16 The National Atmospheric Emissions Inventory estimates a consistent time series of UK emissions from 1990 to the reporting year minus 2, however this can vary by greenhouse gas and air quality pollutant due to data availability and reporting requirements. Therefore emissions data for some smaller facilities in the Solent have been accessed through direct correspondence and others not present in the NAEI have been estimated. This estimation is discussed in further detail in Section 5.1.1 and Appendix B.

FIGURE 5: Current industrial emitters in the Solent region

Bubble size is proportional to 2021 CO_2 emissions as reported by the National Atmospheric Emissions Inventory of point sources.[17]



- **Energy engineering and infrastructure development**, such as Bilfinger, Enoflex, RWE, SSE and Vestas.
- **Other manufacturing, technology and chemical production** such as Cooper Vision, GEO Specialty Chemicals, Huhtamaki, IBM, Leonardo and Pall Europe.

Major point source emitters within the Solent region are shown above in Figure 5.

5.1.2 Scope 1 baseline and BAU forecast

This section considers the current emissions within the Solent region and emissions projections under a "business-as-usual" (BaU) or baseline scenario, where no further decarbonisation activities occur within the Solent beyond committed projects and conservative decarbonisation projections.[18] This scenario highlights the risk of inaction on emissions in the region.

Opportunities and analysis of deep decarbonisation within the Solent region are explored in Section 5.2 and throughout the remainder of the report.

17 *"Emissions from point sources"*, National Atmospheric Emissions Inventory

18 Full details of the data sources and assumptions used to generate baseline emissions and BaU emissions forecasts are included in Appendix A.

As per Figure 6, direct greenhouse gas emissions (Scope 1 emissions) from industrial emitters in the Solent region in 2023 are estimated as 5.3 $MtCO_2e$, with these dominated by just a few sectors.

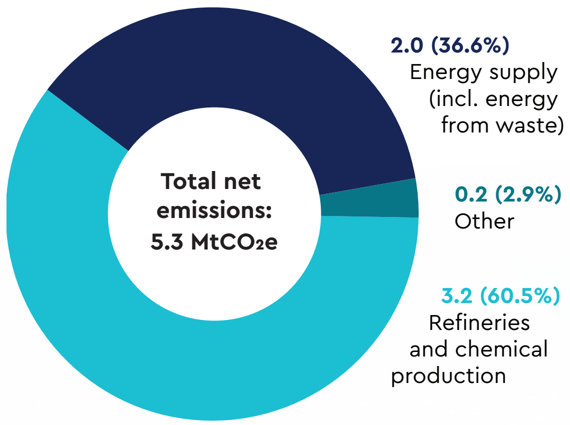
- The **refining and chemical production sector** produces 61% of these emissions, equivalent to 3.2 $MtCO_2e$.
- **Power generation (including energy from waste)** contributes a further 37% of scope 1 emissions in the region, totalling 2.0 $MtCO_2e$.
- **Other sectors** including hospitals, universities, and small manufacturing sites in the region contribute the remaining 3% of scope 1 emissions, equivalent to 0.2 $MtCO_2e$.[19]

It is noted that 5.3 $MtCO_2e$ is likely to represent an underestimate of current scope 1 industrial emissions within the Solent region. This scope 1 emissions inventory is developed using point source emissions datasets, which only include data for facilities where organisations are required to report annual emissions. As a result, emissions data typically cover only larger facilities and may not capture data for smaller sites.

Appendix B describes additional analysis performed to estimate total non-domestic natural gas demand. This approach suggests that **an additional 1.6 $MtCO_2e$ may have been emitted in 2023 through natural gas consumption within the Solent region**, by smaller industrial sites which are currently not required to report emissions.

Due to poorer data availability of emissions data for smaller sites, the focus of emissions and decarbonisation modelling in the Solent LIDP is the baseline established using point source emissions data. However, the potential decarbonisation opportunities for smaller sites which may not trigger reporting thresholds remains a consideration.

FIGURE 6:
Scope 1 baseline emissions by sector in 2023 ($MtCO_2e$/year)[20]



5.1.3 Scope 1 business-as-usual forecast

Assumptions for a BaU forecast results in a peak of ~5.8 $MtCO_2e$/year from 2025 to 2040, followed by a gradual decrease in emissions to just over 5 $MtCO_2e$/year by 2050, a reduction of 11% from peak value. From the 2023 baseline, a 2% decrease is observed, amounting to 0.13 $MtCO_2e$. Therefore, without considering new decarbonisation initiatives, the Solent region is poised to remain high-emitting, primarily attributable to the significant emissions from the refining, chemical production and power generation sectors.

19 Although significant players in regional infrastructure, scope 1 emissions from ports in the Solent region are not included in analysis in this report. Scope 1 emissions data has not been available for these during this work. No ports have significant enough emissions to trigger emissions reporting thresholds, so emissions are anticipated to be small compared to other facilities in the region, but understanding port emissions and potential opportunities for decarbonisation is a target for future work.

20 All Scope 1 emissions shown here are from industry in the Solent region, expressed in tons of carbon dioxide equivalent (CO_2e). This excludes agriculture, land use, land-use change, and forestry (LULUCF), transport and residential emissions.

FIGURE 7: **Scope 1 Business-as-usual emissions forecast, 2023–2050**

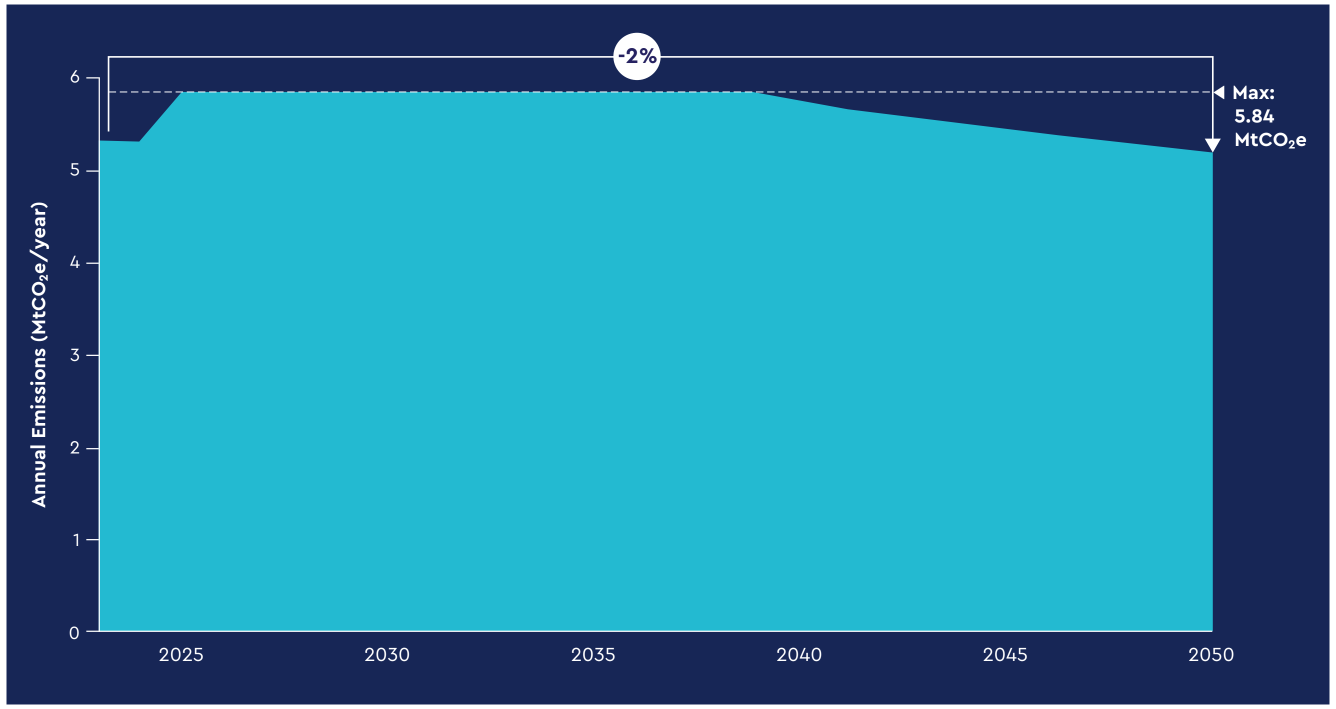
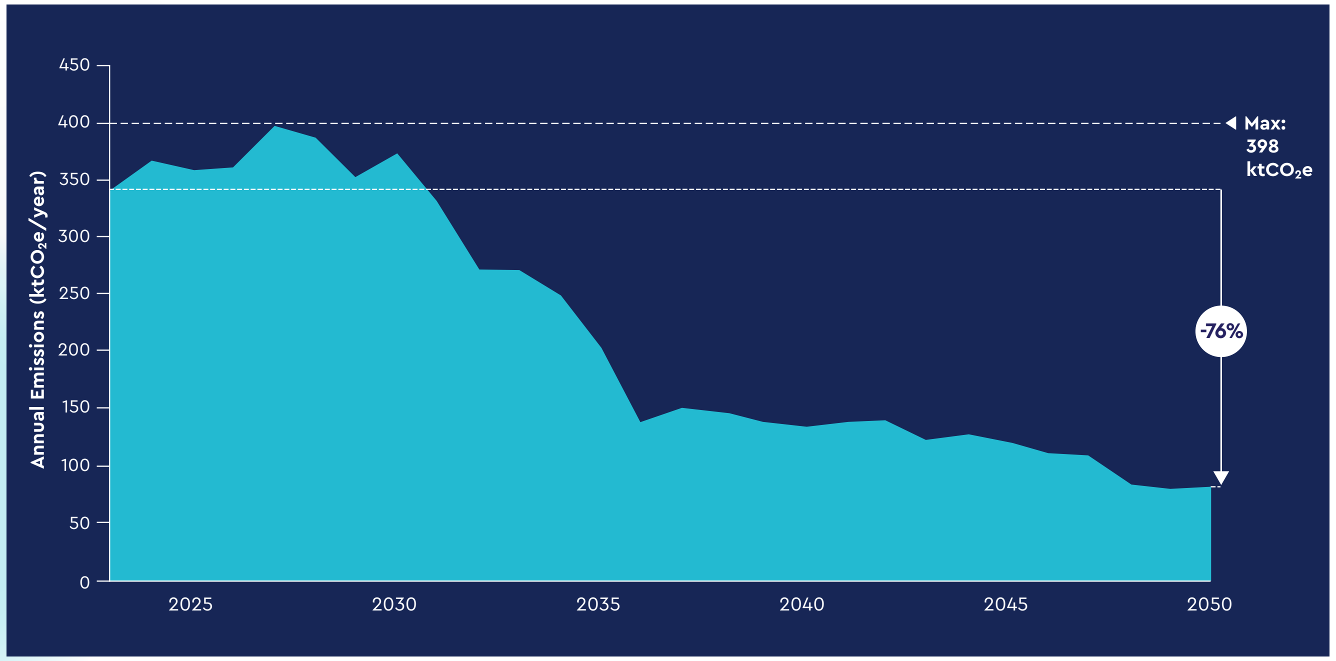


FIGURE 8: **Scope 2 business-as-usual emissions forecast, 2023–2050 ($ktCO_2e$/year)**



5.1.4 Scope 2 baseline and BAU forecast

Scope 2 emissions are indirect emissions associated with the purchase of electricity, steam and heat. Industry in the Solent region currently also incurs notable scope 2 emissions of just under **350 $ktCO_2e$/year**, with over 2,500 GWh of electricity consumed in 2023 across all commercial and industrial facilities in the Solent region.[21]

21 It is noted that there is a risk of some double counting of emissions between scope 2 and scope 1 attributed to power generation facilities. This is further discussed in Appendix A.

A BaU forecast for scope 2 emissions is based upon the most conservative of National Grid's *Future Energy Scenarios*.[22] Even under this scenario, electricity consumption across industry in the Solent region is anticipated to increase gradually to 2050, driven by some anticipated rise in process electrification (e.g. through heat pumps) together with the economic growth of industrial entities in the region.[23]

However, falling grid intensity across the UK, due to increasing deployment of renewables and other low carbon energy sources, will likely lead to significant decreases in scope 2 emissions across industry in the Solent. Under the BaU forecast, this is projected to fall to 83 $ktCO_2e$/year by 2050, a 76% reduction on 2023 (see Figure 8).

5.1.5 Implications for the Solent region

Across the Solent region today, industrial emissions are dominated by scope 1. Nearly 94% of 2023 Solent emissions across scope 1 and 2 were scope 1. Unless significant decarbonisation initiatives targeting these direct emissions are undertaken, large industrial emissions can be expected to remain towards 2050.

Decarbonising these emissions in the Solent region will require a range of technologies. Immediate action could include efficiency improvement measures and energy consumption reduction. As the electricity grid continues to decarbonise, there are also near-term opportunities for smaller facilities to explore electrification and reduce scope 1 emissions. However, the electricity network in the region is already highly constrained at many key locations. Increased industrial demand for electricity will likely further increase the need for grid capacity upgrading, particularly at points that are already constrained within the network.[24]

Significant further action across other decarbonisation technologies will also be necessary to abate these major sources of direct scope 1 emissions. New major infrastructure, for example producing low carbon fuels such as hydrogen and allowing capture and storage of CO_2, is likely to form part of the solutions required to achieve decarbonisation in the Solent region.

5.2 DECARBONISATION PATHWAYS FOR THE SOLENT REGION

5.2.1 Decarbonisation scenarios

To understand the potential different futures for industry in the Solent region, a set of scenarios were established and modelled as part of analysis for the Solent LIDP. These represent six potential futures for industry in the Solent region, with differing levels of infrastructure delivered and clean energy available to industry.

These scenarios are summarised in Figure 9. In increasing order of ambition, these include:

- A **Baseline** scenario, highlighting the limited emissions reductions likely to be achieved with minimal action to decarbonise industry in the Solent region.[25]
- The **Advancing projects with constrained infrastructure** scenario, which sees the deployment of decarbonisation projects which are achievable in the nearer term, and largely achievable without additional major infrastructure. This includes decarbonisation in alignment with public plans at smaller emitting sites, such as hospitals and universities, and also sees decarbonisation at the Marchwood ERF via capture of CO_2 emissions. In this scenario, CO_2 is transported by ship and/or rail to an appropriate storage location, as no local CO_2 storage location (e.g. in the English Channel) is assumed to be available. Major emissions reductions are not achievable for larger industrial facilities in this scenario, due to limited new infrastructure availability.
- Three "partial decarbonisation" scenarios: (i) **Barriers to CCS**, (ii) **Barriers to hydrogen**, and (iii) **Barriers to electrification** – each considering further emissions reductions achieved by deployment of some key, anchor infrastructure. This infrastructure is across carbon capture and storage;

22 The 'Counterfactual' scenario in the Future Energy Scenarios report. Further discussion of this scenario is included in Appendix A. Source: "*2024 Future Energy Scenarios report*", National Grid

23 See *Appendix A* for further details.

24 A further contribution to this challenge will be increased demand for electricity from other sectors, such as ports, electrified transport and new sites including data centres.

25 Assumptions are aligned with the business-as-usual assumed in Section 5.1.

low carbon hydrogen; and upgrading of electricity networks. However, each of these scenarios explores a case where one of these infrastructure developments does not progress, testing the extent to which the absence of each may prevent full decarbonisation of industry in the Solent region.

- A **deep decarbonisation** scenario represents a realistic best case for decarbonisation of industry in the Solent region. This includes delivery of all key anchor infrastructure, planned near-term decarbonisation projects and further decarbonisation activities to drive progress towards Net Zero emissions in the region.

Scenarios have each been explored through detailed system modelling, which seeks to optimise the decarbonisation potential of industrial sites based upon current best estimates of technology development, costs and assumed infrastructure availability by scenario. Scenarios also include some sensitivities around decarbonisation trajectory of the wider economy, based upon National Grid's *Future Energy Scenarios*.

FIGURE 9: Six modelled scenarios for future decarbonisation of the Solent region

Modelled emissions trajectories under each of these scenarios are included below. Figure 10 shows the comparative emissions trajectories that would be anticipated under each scenario, while Figure 11 presents the cumulative emissions abated across each.

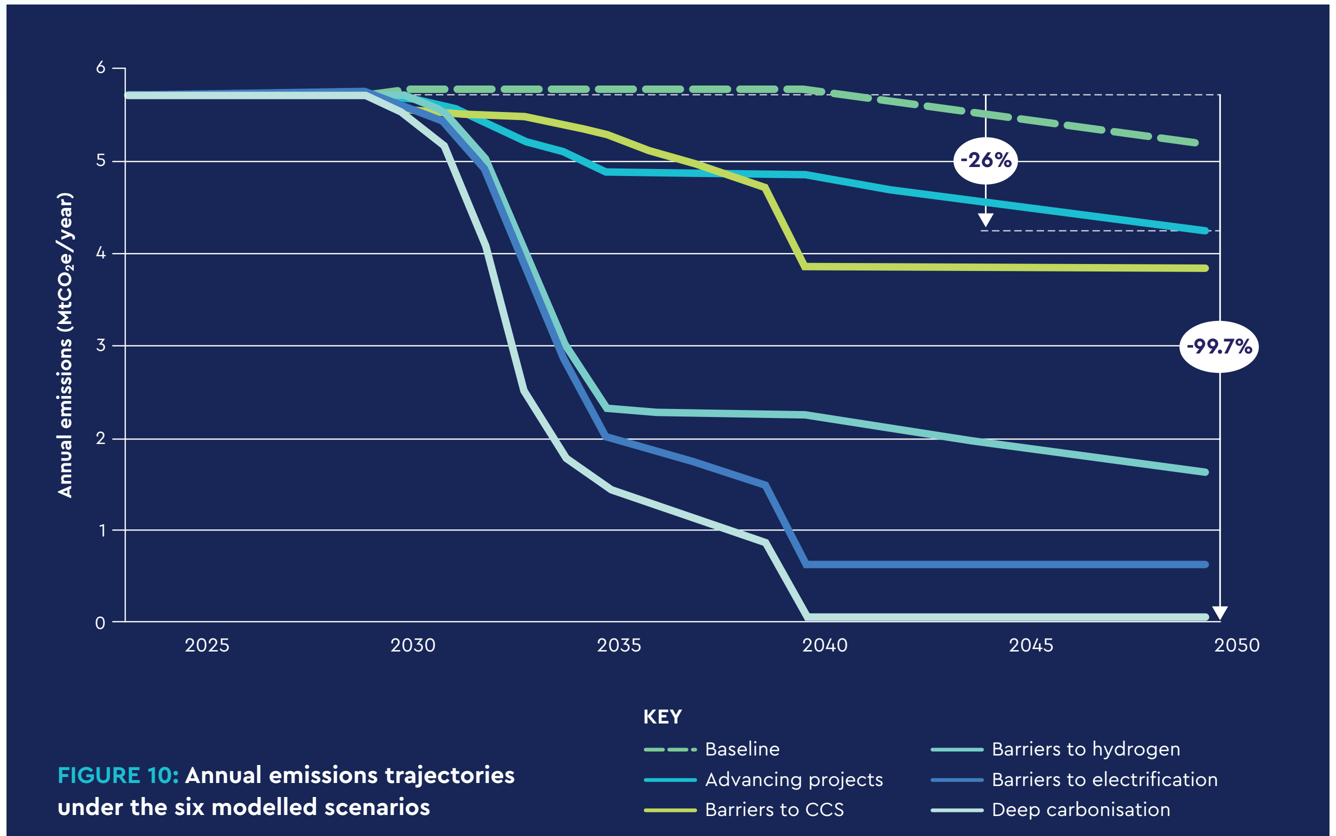


FIGURE 10: Annual emissions trajectories under the six modelled scenarios

The **deep decarbonisation** scenario suggests that the Solent region could achieve emissions reduction of over 99% by 2050, compared to current emissions. Cumulative emissions of over 90 million tCO_2e could be abated through the actions in this Deep decarbonisation scenario, compared to the baseline trajectory.

In comparison, the **Advancing projects with constrained infrastructure** scenario suggests a reduction in emissions of just 26% could be achieved by 2050, should only limited decarbonisation infrastructure become available in the Solent region. Projects that are considered in this scenario, typically nearer term projects and with limited wider dependencies, should still be progressed – abatement of 16 $MtCO_2e$ could cumulatively be abated by 2050 compared to a baseline. This includes carbon capture at Marchwood EfW which means emissions fall below the *Barriers to CCS* scenario in 2035, but does require CO_2 storage elsewhere. However, the significant shortfall compared to a Deep decarbonisation scenario highlights the reliance of industry in the Solent region on the availability of large-scale infrastructure development.

The **partial decarbonisation** scenarios further highlight the dependence of the region on this key supporting infrastructure.

These three scenarios all leave residual emissions of at least 0.6 million tCO_2e by 2050, highlighting that to fully decarbonise industry in the Solent region **hydrogen production; CO_2 transport (and storage, noting that storage could occur outside of the Solent via shipping or rail transport of CO_2); and grid upgrading are all likely to be required**.

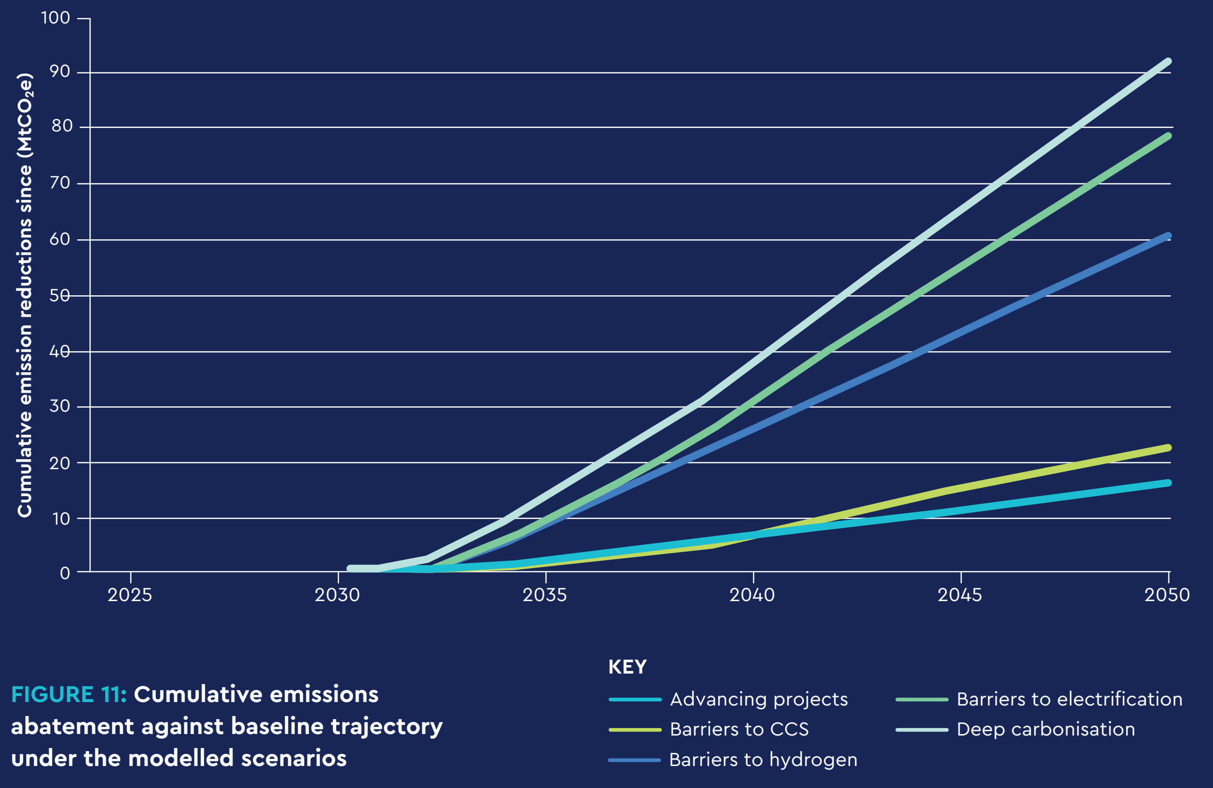


FIGURE 11: Cumulative emissions abatement against baseline trajectory under the modelled scenarios

5.2.1.1 ACHIEVING NET ZERO INDUSTRIAL EMISSIONS

Even under the most ambitious scenario modelled, a small proportion of residual industrial emissions remain by 2050. Some emissions sources, particularly at large, complex industrial facilities, may have no realistic means of being abated. Appropriate emissions reduction technologies may be technically challenging or cost prohibitive to deploy. In addition, some abatement technologies are unlikely to achieve 100% emissions reduction – for example, modern carbon capture technologies typically achieve capture rates of around 90–98% of CO_2 produced.[26]

The industrial sector in the Solent may therefore rely on some "negative emission" or "greenhouse gas removal" technologies, to align with the UK's Net Zero target for the wider economy. Some negative emissions are already integrated within this modelling – as discussed in more detail in Section 5.2.2.1, achieved through capturing and storing biogenic CO_2 emissions from Veolia's Marchwood energy recovery facility. The magnitude of these negative emissions is however insufficient to offset residual emissions within industry.

Some residual emissions from hard-to-abate sectors being offset by negative emissions is aligned with the Climate Change Committee's Net Zero scenarios for the Sixth Carbon Budget. Major routes to achieving negative emissions include bioenergy with carbon capture and storage (BECCS) or storage of CO_2 from direct air capture (DAC) technology.[27] As discussed in Section 5.2.2.4, CCS in the Solent region could also potentially play a role in delivering capacity for these technologies in the UK.

26 "Carbon capture, utilisation and storage", IEA
27 "The Sixth Carbon Budget", Climate Change Committee

5.2.2 Key technologies to achieve decarbonisation

Levels of abatement achieved by technology have also been explored as part of the scenario modelling in the Solent LIDP. This indicates that four overarching technologies are sufficient to achieve a reduction of over 99% of emissions across industrial facilities in the Solent region by 2050:

- Energy and resource efficiency
- Process electrification
- Low carbon fuel-switching (such as to hydrogen);
- Carbon capture and storage (CCS).

Figure 12 (overleaf) presents a comparison by scenario of modelled abatement achieved by each of these technologies across major emitters within the Solent. This is shown both by year and cumulatively across the period of 2024 to 2050. These scenarios show a significant role in abatement through CCS and low carbon fuel-switching, in particular to hydrogen. Electrification and energy efficiency measures appear to play a smaller but still significant role in driving the region towards Net Zero.

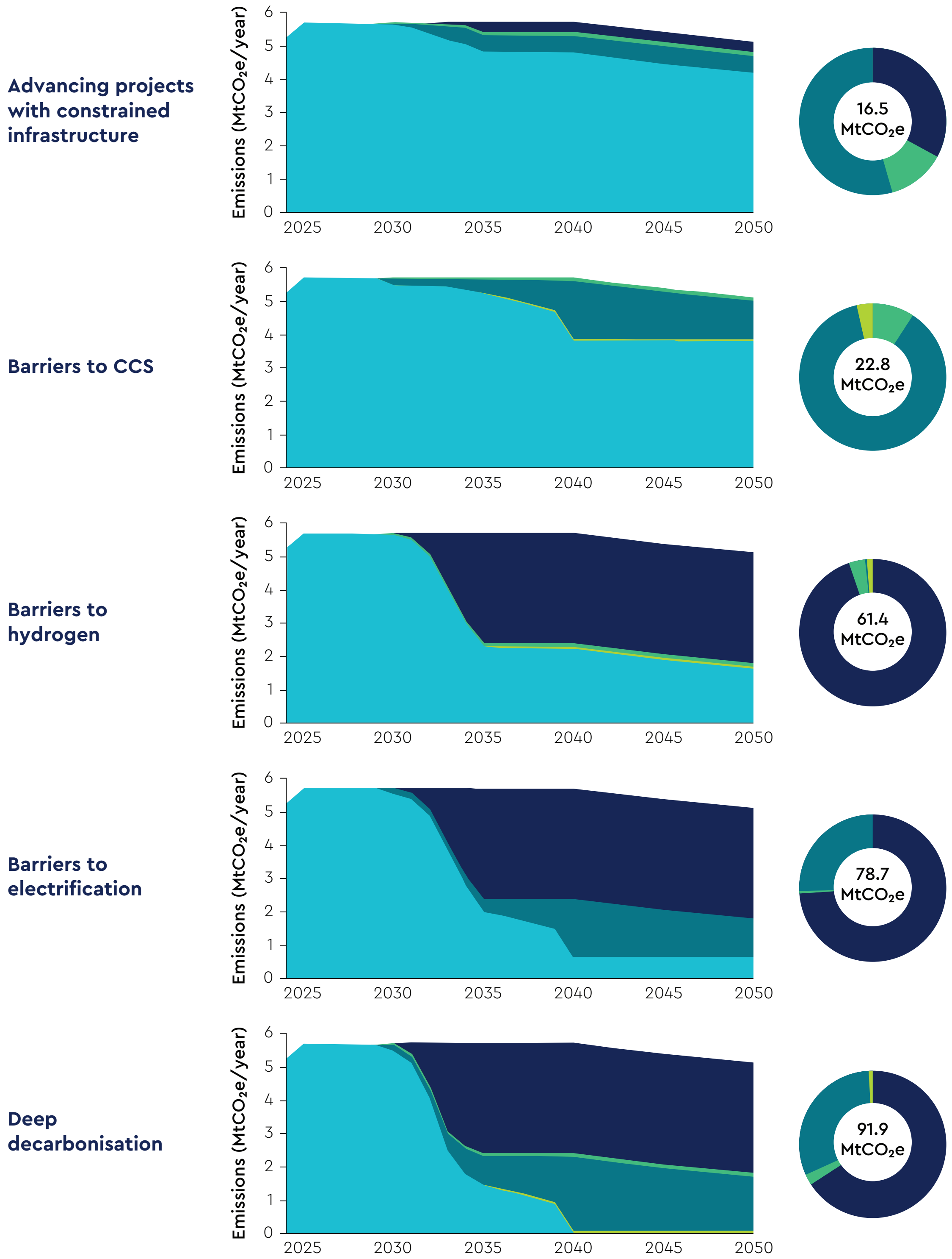
Note: This analysis is likely to show an underestimate of the impact of these decarbonisation technologies, in particular electrification and energy efficiency measures. Significant natural gas emissions across smaller industrial sites may have represented an additional 1.6 $MtCO_2e$ of scope 1 emissions in 2023, as discussed in Appendix B. Electrification and efficiency improvements could both play key roles in abating these emissions.

FIGURE 12

Emissions abatement achieved by technology and by scenario

The graphs compare scenario emissions trajectories to the baseline, with portion of abatement achieved by each technology shown. Pie charts show total abatement by technology between 2023 and 2050.

KEY
- Carbon capture
- Process change
- Fuel switching
- Electrification
- Residual emissions



5.2.2.1 ENERGY EFFICIENCY IMPROVEMENTS

It is widely acknowledged that implementing some decarbonisation technologies, such as fuel switching or CCS, will result in increased fuel costs for industry. It is therefore crucial that energy and resource efficiency levers are adopted primarily wherever possible. These levers reduce the energy and resources used in the production of industrial goods and products. Improvements in energy and resource efficiency can play a particularly significant role in reducing industrial emissions through the 2020s, as they are not reliant on large infrastructure projects as is the case with most CCS or fuel switching projects. Despite the up-front investment required for many of these energy efficiency projects, they save costs from reduced energy and resource consumption and can often achieve payback periods of fewer than five years.

These measures are central to the decarbonisation opportunities identified by small to medium sized manufacturers within the Solent LIDP team. Examples of such projects include installation of LED lights (with significantly lower energy consumption than traditional lighting), upgrading to more modernised boilers with more efficient fuel consumption and retro-fitting of variable speed drive (VSD) technology onto on-site compressors. Decarbonisation modelling, as introduced above, suggests that potentially **more than 2 $MtCO_2e$ could be abated through efficiency measures across industrial sites in the Solent region by 2050**.[28]

More detailed discussion of decarbonisation opportunities explored by GEO Specialty Chemicals, Enoflex, and StandardAero as part of the LIDP team are included in the following case studies.

CASE STUDY
ENOFLEX

Enoflex is a Southampton-based manufacturer of non-metallic composite material pipes, designed to be corrosion-resistant and effective at low temperatures. Target markets for these products are in current and emerging energy industries for transport of liquefied gases, such as LNG, liquefied CO_2, liquid ammonia and liquid hydrogen. The lighter weight of a composite material pipe can offer a smaller lifecycle carbon footprint than a conventional metallic competitor.

Emissions reduction opportunities

Enoflex's manufacturing processes is entirely electric, making efficiency improvements the key opportunity to achieve emissions reduction at its Southampton factory.

Enoflex has undertaken a feasibility study into potential efficiency measures, in particular identifying a custom, improved control system for its additive-manufacturing process. Improvements to this system can lead to faster placement of the composite material during pipe manufacture. This would lead to less energy consumption and result in an estimated 30% reduction in scope 2 emissions. In addition, composite material used as feedstock will be utilised more efficiently, leading to a cost-optimisation in the final pipe product and reduced upstream emissions for manufacturing.

Detailed design and implementation of this control system is now planned, where Enoflex is due to work in partnership with a Solent-based control system specialist. Learnings from this improved control system equipment development is also being integrated into Enoflex's expansion plans for a second, larger manufacturing line.

28 Cumulative abatements of up to 2.1 $MtCO_2e$ are modelled to be achieved across the scenarios through "Process change". This includes efficiency measures, in addition to other decarbonisation measures that do not fall into other categories or are not disclosed by facilities. However, as total emissions may be underestimated in scenario modelling due to additional gas demand, the role of efficiency measures and other process changes may be yet higher.

CASE STUDY
GEO SPECIALTY CHEMICALS

GEO Specialty Chemicals operates a facility in Hythe, manufacturing a range of high purity specialty chemicals. Products include chemicals for coating and resin additives, and a wide range of dispersants, surfactants and additives.

As part of the LIDP project, GEO has explored and evaluated a wide range of solutions for emissions reductions, through process modifications, improved equipment efficiency, electrification and renewable electricity generation. Continued advancement of these projects could see the site achieve significant emissions reductions.

PROJECT	POTENTIAL BENEFITS	DESCRIPTION
Methanol by-product utilised by nearby site	Almost **200 tCO_2/year avoided** in shipping emissions.	- An aqueous methanol by-product produced at the plant is now supplied to a nearby denitrification plant. This avoids virgin methanol needing to be shipped long distances, avoiding significant shipping emissions.
Digital twin of facility	**~5% reduction in site emissions.**	- An AI-powered digital twin tool was developed to explore on-site activities that drive energy demand and anticipate future demand. - Potential operational measures to improve efficiency have been identified, including scheduling of annual production and prioritisation of process improvements or plant modifications.
Steam production using geothermal heat	**Lower emission steam production** than natural gas boilers.	- Studies have been undertaken to evaluate opportunities to replace gas-powered steam generators with a geothermal system. A number of options and configurations have been assessed. - A potentially promising solution has been identified using a 5km well to preheat water to 80°C, which is being considered further for deployment.
Solar PV installation on-site	**10% of the site's electricity** could be met with on-site renewable generation.	- An opportunity has been identified to generate a proportion of GEO's on-site electricity needs using rooftop solar, reducing scope 2 emissions.
Installation of high efficiency and hydrogen-ready boilers	- **25% reduction in boiler CO_2 emissions** if using natural gas - **Potential 100% reduction** if using hydrogen.	- GEO is exploring replacing existing natural gas-fired boilers. New boilers could provide two key benefits: o **Efficiency:** the boilers are significantly more efficient, reducing emissions and costs from natural gas usage. o **Hydrogen-ready:** new boilers can accept hydrogen fuel (or blends of hydrogen with natural gas) to achieve further emissions reduction when this fuel becomes available.
Variable speed drives on pumps	**Reduced energy use from pumps**, which currently consume 12% of site electricity.	- Feasibility has been explored of retro-fitting variable speed drive (VSD) onto existing pumps. VSD can reduce energy consumption, by matching pump speed to match demand. - More detailed studies are ongoing, in particular to conduct review of safety requirements, instrumentation needed to collect data and reliability.
Electrification of steam process jets	Site emissions **reduced by up to 7%**.	- Natural gas-fired process jets are currently used for steam production and achieving vacuums. This process could be electrified by introducing electric vacuum pump systems. - While this would increase on-site electricity usage by around 2.5%, significant emissions reductions could be achieved. - GEO is considering this opportunity for jets used in distillation processes, but in future could also electrify jets in other parts of the process.

CASE STUDY
STANDARDAERO

StandardAero is a global player in the aerospace and aviation sectors, with specialism in maintenance, repair and overhaul (MRO) of aircraft engines and components, with key facilities sited in Hampshire, within the Solent region.

The organisation has been considering a number of pathways by which efficiencies and deep decarbonisation can be achieved within their Hampshire sites through better understanding of current energy usage, reducing wastage, and introducing low carbon technologies to realise process improvements.

PROJECT	POTENTIAL BENEFITS	DESCRIPTION
Energy awareness	Estimated **0.5% reduction in electricity consumption**	- Increased energy awareness across staff is being encouraged, to minimise wastage.
Improved sub-metering	**Increased understanding** of energy usage across the site, supporting **further optimisation of other measures**	- Further installation of energy meters is being considered across the sites, to improve transparency of energy usage at a more granular level. - This could allow improved targeting of improvements and energy use reduction measures.
Upgrading of BMS	**Further reductions in energy usage**, with 34% reduction in natural gas consumption already achieved	- StandardAero already operate with a Building Management System (BMS) for 90% of their Gosport site; a smart system which seeks to optimise energy usage using sensor data from across the site. - By integrating the improved sub-metering and expanding to cover the remainder of the site, operation could be improved further.
Reduced compressed air leakage	Reduced air leakage and **potential reduction of 20–50%** in energy in compressors not currently using VSD	- StandardAero's site has an extensive distribution system providing compressed air across the facilities. An air leak survey has recently been undertaken at the Gosport site to identify and repair significant leak points, reducing compression energy requirements. - Additional measures are being considered to reduce leakage further, such as regular surveying using ultrasonic equipment and upgrading of equipment at points at highest risk of leakage. - Further, some on-site compressors could be retro-fitted with variable speed drive (VSD) technology, improving energy efficiency.
Refurbishment and replacement of main boilers	**Potential reduction of over 20%** in boiler fuel consumption.	- Boiler replacements are being considered which, through exhaust gas analysers, can reduce fuel requirements and produce cleaner exhausts, via minor adjustments to combustion configuration. - Heat recovery technology could be installed with boilers, to reduce fuel requirements further.
LED lighting upgrading	**Significant reductions** in energy use for lighting	- A process of replacing lighting with LED alternatives is currently underway at the site. This is due to continue and could be further accelerated.
Extractor fan upgrading	**Potential 18% improvement** in extractor fan efficiency	- Current technology used in extractor fans could potentially be replaced, installing electronically commutated fans with built-in speed control. It is estimated that these systems could be significantly more efficient than the current configuration.
Network circulation pumps replacement	**Reduction in energy requirements** for pump and motor operation	- StandardAero has identified the potential to upgrade pumps and motors in the site's boiler house with more modern equivalents. This may allow the use of smaller motors for the same flow rate, reducing energy requirements.

PROJECT	POTENTIAL BENEFITS	DESCRIPTION
De-stratification fans installation	**15% reduction** in space heating energy requirements	- De-stratification fans are already used in some areas of the site to displace warm air from the roof void into the working zone below. This reduces energy requirements of space heating. - StandardAero is considering further installation of these, across all suitable areas.
Solar PV installation	Potential to generate **over 1,200 MWh of renewable power** each year	- Large roof space has been identified to potentially support significant solar generation capacity, for power use on site and potential export to grid.

5.2.2.2 ELECTRIFICATION

Fossil fuel driven processes can also be decarbonised by replacing these processes with electrified equipment, such as electric boilers or heat pumps. Process electrification abates direct (scope 1) emissions and becomes an increasingly attractive decarbonisation opportunity as grid electricity continues to reduce in emissions intensity in the UK.

Figure 12 shows the modelled emissions impact of electrification alongside improved material and energy efficiencies measures (efficiency measures are discussed further in Section 5.2.2.1). This analysis suggests that **close to 1 $MtCO_2e$ could be abated from industrial facilities by 2050 through electrification**, and the true value could be significantly higher.

As described in Section 5.1, point emissions datasets which form the basis of this modelling analysis typically only include emissions from larger industrial facilities, where emissions reporting is required. A separate analysis (discussed in detail in Appendix B) suggests that additional natural gas emissions up to 1.6 $MtCO_2e$ may have been produced by smaller industrial facilities in the Solent region in 2023. Electrification represents a key technology opportunity for decarbonisation of these smaller sites.

Electrification as a key opportunity

Industrial sites already have electricity grid connections in place, so may be able to achieve some level of electrification without the need for additional network infrastructure.

Electrification represents a decarbonisation opportunity available to smaller or more dispersed sites, alongside larger industrial facilities. Dispersed sites are likely to be less suited to utilising other key technologies such as CCS and hydrogen production. These technologies require large-scale infrastructure development and are likely to be most economical when deployed around clusters of large point emitters. Retro-fitting of carbon capture equipment or installing hydrogen-ready appliances can also often benefit from economies of scale – leading to challenges for smaller sites in deploying these technologies.

Challenges to electrification

However, **barriers remain to introduction of electrified technologies in industry**.

Technology limitations: Not all industrial processes can currently be electrified with current technologies. This is particularly challenging where high temperature heating is required.

Cost: Electrification typically requires full replacement of equipment (rather than modification or retrofitting), incurring high upfront capital costs. Additionally, despite electric equipment often being more energy efficient than natural gas combustion processes, high costs of electricity relative to natural gas will often lead to higher overall operational costs of electrified equipment. Business cases for such projects may be improved where sites generate renewable power on-site, for example through rooftop solar.

Electricity network constraints: The current electricity network is already highly constrained in the Solent region, and these constraints may prevent industrial sites being able to access sufficient power to electrify processes. This is an additional challenge alongside other sectors anticipated to demand more electricity, such as at ports, electrified transport and new sites including data centres.

Analysis by SSE Energy Solutions as part of the Solent LIDP suggests that all Grid Supply Points (GSPs) in the region – the substations that connect the wider transmission network to the local distribution network – are already close to capacity and that there is very little opportunity to connect additional generation or demand at this level. At some Bulk Supply Points (BSPs) in the region (the substations connecting GSPs to the lower voltage part of the network), capacity for new generation and demand connection is available. However, in many other locations, such as BSPs around Southampton and Fawley, significant constraints are also already seen.

Sites seeking to newly connect to the electricity network or expand connection capacity may in the immediate term need to focus upon connections at BSP level (or below) in locations where fewer constraints are seen. Operation within existing grid constraints can be further enabled where electric loads can operate flexibly (e.g. avoiding times of peak demand) or may be directly connected to new generation (e.g. on-site renewables) by private wire.[29]

However, to fully enable electrification of industry in the Solent region, upgrading of components in the electricity network will be required to overcome these constraints and capacity limits. This reinforcement process can be time-consuming and costly, with costs seen by both connecting parties and wider network consumers. Phased investment in this infrastructure should therefore target and prioritise urgent constraints that could prevent industrial decarbonisation in the immediate term.

5.2.2.3 LOW CARBON FUEL SWITCHING

Consumption of fossil fuels such as natural gas is a major emissions source at industrial facilities across a range of sectors and facility sizes. Natural gas combustion is used for generating heat in equipment such as boilers, furnaces and kilns, in addition to on-site power generation. A key approach to decarbonising these processes involves fuel-switching to lower carbon fuels, such as hydrogen or biofuels.

Low carbon hydrogen

Hydrogen is a potential fuel and clean energy source, which produces no direct emissions when used or burned. Instead, hydrogen (H_2) reacts with oxygen (O_2), to simply produce water vapour (H_2O).

However, despite no emissions at point of use, most hydrogen used in industry in the UK today is emissions-intensive to produce. In so-called "grey hydrogen" production, natural gas is reformed into hydrogen, with carbon dioxide released as a by-product.

Hydrogen production in future does not need to be major source of greenhouse emissions – hydrogen produced via low emission pathways can be considered a clean energy source and could play a key role in decarbonising industry and other sectors, as a potential replacement for fossil fuels.

Two key technology options can be used to produce low carbon hydrogen:

- **Blue hydrogen** is produced by reforming natural gas into hydrogen and carbon dioxide, with the carbon dioxide captured and stored using CCS.
- **Green hydrogen** is produced via electrolysis, where water is separated into hydrogen and oxygen, using renewable electricity to power the process.

The Solent region could be well-placed to produce low-carbon hydrogen via both of these routes. Should large-scale carbon sequestration be established in the English Channel and infrastructure established to transport CO_2 from the mainland, blue hydrogen plants could be sited to access this opportunity and deliver large volumes of low carbon hydrogen to the region. A large blue hydrogen production plant was previously planned by ExxonMobil alongside its development project of a CO_2 sequestration site and pipeline. However, as this project has now been halted, future availability of blue hydrogen in the region is uncertain.

Green hydrogen production could also be established in the region. Two production facilities have previously been considered, which could deliver combined production capacity of 400 MW. Alternatively, if hydrogen is not available in sufficient quantities locally, this could become available in the Solent region through production capacity developed elsewhere in the UK and wider infrastructure for hydrogen transmission.

29 The local distribution network is also already subject to an Active Network Management (ANM) system – part of the Southwest Active Network System project – to help allow greater numbers of connections to the distribution network, ahead of transmission network reinforcement. This system operates by closely monitoring use of the distribution network and may see generation curtailed during specific periods. *"SWANS – Southwest Active Network System"*, SSEN

- **Project Union** – being developed by National Gas, the UK's gas transmission operator – is seeking to develop a transmission network of 100% hydrogen pipelines in the UK. This would be developed from both repurposed natural gas transmission pipelines and newly built pipelines to connect major industrial regions, including the Solent region.[30]
- **H2 Connect** is being developed by SGN, that would see further 100% hydrogen pipeline development in the south of England. This would integrate with Project Union, interconnect parts of the Solent region, and potentially also connect to the UK Energy Storage project near Weymouth (see below).[31]

A **UK Energy Storage** project could further support hydrogen availability in the Solent region. This is a potential hydrogen storage facility, planned by UKEn near the Isle of Portland and Weymouth, just west of the Solent region. The project is seeking to establish the UK's largest hydrogen storage site in underground salt caverns. It is estimated that this could deliver 2 billion cubic metres of hydrogen storage, potentially 20% of UK hydrogen storage needs in 2035. Close collaboration with this project could deliver further hydrogen availability to the Solent region.[32]

Fuel-switching to hydrogen could achieve significant emissions reductions across industry in the Solent. Modelling suggests that emissions of up to around **28 $MtCO_2$ could be abated through introduction of hydrogen by 2050**, if significant clean hydrogen production capacity becomes available in the early to mid-2030s within the region. Key sources of demand for hydrogen could be industrial heat at the Fawley petrochemical complex and a number of other manufacturing sites in the region. Hydrogen blends could also be introduced into gas-fired power stations such as at Marchwood, to reduce emissions intensity of this on-demand power generation.

Complexes such as Fawley also already require large volumes of hydrogen, in particular to remove sulphur from fuels and other petrochemicals. This is currently produced as "grey hydrogen" using hydrocarbons within the complex, but could be replaced with hydrogen from a low carbon source. Further, hydrogen is a highly versatile fuel, that could be used to replace natural gas in domestic and commercial heating, as well as in transport to replace petrol or diesel. If delivered at low-cost, at-scale and with sufficient hydrogen distribution infrastructure, **abatement potential via fuel-switching to hydrogen in the Solent region could be significant**. However, the costs of low carbon hydrogen production, via either the blue hydrogen or green hydrogen routes, remain significantly higher than costs of natural gas and grey hydrogen production. Supply of hydrogen will also rely upon infrastructure development beyond production facilities, such as distribution pipelines and storage facilities. The case for establishing hydrogen supply infrastructure is likely to be strongest in geographical clusters of offtakers – hydrogen distribution is likely to be significantly more challenging to more dispersed industrial sites within some parts of the Solent region.

The low carbon hydrogen market in the UK and globally remains nascent, with significant uncertainty around when hydrogen may become available to industry in regions such as the Solent. Some technology upgrades can be chosen to manage this uncertainty – for example, GEO Specialty Chemicals is considering potential upgrade of its boilers to "hydrogen-ready" models, but that would deliver a 25% efficiency improvement in the short-term while continuing to use natural gas.

However, for many potential hydrogen use cases, other decarbonisation options are available, such as switching to biofuels or process electrification. These opportunities could be available in the more immediate term – industrial sites may opt to pursue these in the absence of clarity on future hydrogen production, availability and prices.

30 "Project Union", National Gas
31 "SGN and NGT accelerate hydrogen plans for Scotland and southern England", SGN
32 "UK Energy Storage, Portland", UKEn

Bioenergy

Fuel-switching to use bioenergy is an alternative opportunity to industrial sites for industrial heat or power generation. Biomass can be combusted directly or processed into fuels such as bio-gas or bio-diesel. These fuels are renewable and low emissions, as any CO_2 released during combustion has previously been absorbed from the atmosphere via photosynthesis.

5.2.2.4 CARBON CAPTURE AND STORAGE

Carbon capture and storage – or CCS – technologies offer the opportunity for carbon dioxide streams to be safely and permanently stored, rather than emitted into the atmosphere and contribute to climate change.

CCS could represent a key opportunity to abate industrial emissions in the Solent region, such as ExxonMobil's Fawley Petrochemical Complex, Veolia's energy recovery facility (ERF) plant at Marchwood and other large emitters in the area.[33] Locations in the English Channel near to the Solent region are geologically suitable and well-placed for large-scale carbon sequestration. Stored in saline aquifers, CO_2 could be injected below the seabed and remain permanently stored, preventing emissions into the atmosphere.

CCS has the potential to be the **single most-effective abatement lever for reducing industrial emissions in the Solent region**. The decarbonisation scenario modelling (introduced in Section 5.2.1) suggest that CCS could cumulatively **reduce emissions in the region by around 60 $MtCO_2$ by 2050**, should large-scale storage be available by 2030, with capacity to store around ~3.5 $MtCO_2$/yr.

CO_2 storage in the Solent region could also lead to wider opportunities to unlock decarbonisation elsewhere in the UK. Limited geological formations for CO_2 sequestration are available locally to industrial regions elsewhere in the UK, such as South Wales and south-east England. Currently, emissions-intensive industries in these geographies may seek to ship CO_2 into the Solent for sub-sea injection and storage. The Solent region's potential role as an enabler of decarbonisation elsewhere in the UK is explored further in Section 5.3.

Further, should limited CO_2 storage capacity become available in the Solent region, other opportunities may also exist to transport captured CO_2 to other stores, such as those in Track 1 and 2 clusters. One key possibility could be CO_2 shipping to other UK ports or offshore storage sites – existing port infrastructure located nearby to industrial facilities in the Solent region could see sites in the region being well-placed to pursue this. An additional opportunity could also be CO_2 transport via rail.

CCS availability in the Solent region

A project to develop large-scale CCS infrastructure within the Solent region has previously been explored by ExxonMobil, with a connecting CO_2 pipeline into the English Channel from near Southampton. However, in autumn 2024, ExxonMobil halted efforts to develop these projects, citing difficulties in securing sufficient government policies and market conditions making it challenging for the project to proceed.

As a result, the future development of CCS in the region is currently uncertain. This could still represent a significant decarbonisation opportunity in the Solent region, should a developer seek to recommence this work. Industrial emitters in the region may also explore other CCS opportunities to reduce emissions, such as shipping and/or rail transport of CO_2 to alternative storage locations in the UK or seek to utilise carbon dioxide (rather than sequestering in geological formations), for example to produce low-carbon methanol.

33 CCS could also play a key role in decarbonisation, if used for **blue hydrogen production** which can be used to displace industrial fossil fuel use. This is discussed further in Section 5.2.2.2.

CASE STUDY

CARBON CAPTURE AT VEOLIA'S MARCHWOOD FACILITY

Veolia is one of the UK's largest environmental services and waste management companies. Its Marchwood site is a large energy recovery facility (ERF), sanitising residual non-recyclable waste and recovering stored energy to supply up to 16 MW of power into the grid. Although a portion of this waste material is biogenic, fossil hydrocarbon content from plastics in residual waste means that the site is also one of the largest emissions sources in the Solent region.

Veolia has conducted an early pre-FEED study into installing carbon capture equipment at the Marchwood ERF site. This technology could capture and prevent atmospheric release of over 95% of carbon dioxide released at the site.

Carbon capture and storage from Marchwood ERF

Further, work is underway to understand pathways by which CO_2 could be transported and permanently stored. If achieved, this could see ~90 ktCO_2 of emissions abated annually from fossil content in waste and, in addition, capture of ~110 ktCO_2 from biogenic content each year.[34]

Three potential route options to transport CO_2 to long-term sequestration sites are identified:

1. Connection to **a carbon sequestration site in the English Channel**, via a pipeline from Southampton.
2. **Shipping of liquefied CO_2**, from the nearby Marchwood quayside to an available carbon sequestration site.
3. **Transport of liquefied CO_2 by rail**, followed by shipping to an available carbon sequestration site.

Each of these options could support deep decarbonisation of emissions at the Marchwood ERF and, additionally, achieve a source of potentially negative emissions from the biogenic fraction of waste.[35] Although these options are likely to require significant enabling infrastructure, opportunities could also arise for shared infrastructure and potential cooperation with other emitters seeking carbon transport and storage routes.

Option 1 could see Veolia act as a local offtaker alongside other emitters in the Solent region to support potential development of CCS infrastructure in the English Channel.

In Option 2, there could be opportunities to collaborate with and unlock decarbonisation opportunities for more distant emitters dispersed across southern England and Wales, with limited access to local carbon sequestration sites. These sites could utilise new port infrastructure for CO_2 shipping from Southampton, by transporting CO_2 by train into the Solent region to then be shipped to an appropriate sequestration site. This could be enabled due to close proximity between railway infrastructure and the potential shipping location near Marchwood.

Option 3 could be achieved using dedicated CO_2 rail wagons. UK loading gauge wagons with capacity to transport 72 tonnes of CO_2 are currently being designed, and Veolia discussions with logistics operators suggest that up to around 30 such wagons could be accommodated per train. As a result, each train could transport around 2,000 tonnes of CO_2 and around 100 trains journeys may be required per year to transport all CO_2 captured at the Marchwood ERF to a permanent storage location.[36] Sharing of CO_2 rail transport infrastructure with other large emitters could further enable Veolia to access CO_2 stores elsewhere in the UK.

34 "Negative emissions" describe processes by which carbon dioxide or other greenhouse gases are removed from the atmosphere and permanently stored. Combining combustion of biomass with CO_2 capture and permanent storage can achieve this. Without capture, biogenic emissions from combusting biomass can be considered carbon neutral, as plant matter absorbs atmospheric CO_2 during growth via the photosynthesis process. When combined with CCS, this CO_2 is effectively removed from the atmosphere and placed in permanent geological storage.

35 Indirect emissions may also be associated with biogenic waste, such as through transportation and collection.

36 The exact transport capacity per train would be determined by the design of the loading and unloading system, and the proportion of CO_2 that may be left in the wagon during unloading.

Potential utilisation of captured CO_2 in renewable marine fuel production

A further opportunity is identified by Veolia in renewable methanol production. Methanol is a chemical used widely as a basis for many products and other chemicals, and can also be used as a maritime fuel or feedstock for the production of sustainable aviation fuel (SAF). Methanol produced today is typically based on fossil fuel feedstocks and is emissions-intensive in production. Low carbon, renewable methanol can however also be produced via a synthesis process of carbon dioxide and hydrogen, using carbon dioxide of biogenic origin and hydrogen produced with renewable electricity.

Carbon dioxide captured at Marchwood could offer a significant source of ~110 ktCO_2 of biogenic CO_2 each year, that could therefore be utilised locally, rather than transported to a sequestration site. A renewable methanol plant in the Solent region would represent both a key opportunity to decarbonise the region's shipping sector and could access a significant source of demand, with around 200,000 large vessel movements hosted each year between the ports of Southampton and Portsmouth. Potential challenges with this renewable methanol production however exist with access to low cost and low carbon hydrogen. Current estimates suggest that, based on potential costs of CO_2 capture at Marchwood, green hydrogen may need to be available at ~£3/kg to achieve cost-competitiveness with existing fossil methanol production routes.

Decarbonisation outlook for energy recovery facilities in the Solent region

The energy-from-waste sector represents an industry which is likely to rely upon CCS to achieve decarbonisation, with limited alternative technology options and an ever present need for waste sanitation. Under the Climate Change Committee's analysis for the Sixth Carbon Budget, all Net Zero scenarios sees CCS deployed at every UK energy-from-waste facility by 2050.[30]

As a result, there is a key dependency for energy-from-waste facilities at Marchwood and Portsmouth on some form of CCS infrastructure becoming available. Lowest costs for CO_2 transport and storage are likely to be achieved if local carbon sequestration is available in the English Channel. However, with some uncertainty around development of such a project, alternative options may need to be considered.

Opportunities for BECCS in the Solent region

As discussed in Section 5.2.1, it is anticipated that the UK will rely upon some GHG removals to achieve its 2050 Net Zero commitments. These removals are required to offset residual emissions that may exist across the economy, such as from very hard-to-abate industrial processes, remaining fossil power generation and other sectors, such as aviation.

A key technology in achieving this is likely to be bioenergy with carbon capture and storage (BECCS). This sees the use of sustainable biomass or other biogenic content to generate power, heat or fuels, and with CO_2 generated captured and sent to long-term geological storage. In the CCC's Balanced Net Zero Pathway, BECCS facilities across the UK are modelled to remove 22 MtCO_2/year from the atmosphere by 2035, and 53 MtCO_2/year by 2050.[30]

Should infrastructure be developed for carbon capture and storage (CCS) in the English Channel, **the Solent region could become a key location for CO_2 removals using BECCS**. Biogenic CO_2 from energy recovery facilities represents a key opportunity and other CO_2 sources could also potentially be used, such as dedicated energy crops.

However, siting of BECCS projects requires consideration of numerous factors, including cost, environmental impacts and social considerations. Many of these environmental and social impacts on the local region are currently not well understood. The University of Southampton is leading in academic research into deployment of low carbon technologies such as this, for example through work carried out as part of UK Industrial Decarbonisation Research and Innovation Centre (IDRIC) projects. A recent project – "Where to locate new bioenergy with carbon capture & storage? A natural capital approach" – developed a national scale cost minimisation model to explore the spatial implications of BECCS, integrating environmental impacts such as soil carbon, water stress, flood protection and food crop value.[37]

37 *"MIP 8.4: Where to locate new bioenergy with carbon capture & storage? A natural capital approach"*, IDRIC Project led by the University of Southampton, the University of Exeter and the University of California.

As part of this work, The University of Southampton also led a workshop session with key experts and stakeholders to consider both the opportunities from and barriers to deployment of BECCS in the UK.[38] This identified potential trade-offs between energy, agriculture and the environment when considering domestic BECCS deployment, and the need for collaboration and engagement to ensure technology deployment aligns with priorities across other sectors and a just transition. The workshop also highlighted key considerations for policymakers to support BECCS, such as the development of CO_2 removal markets and business model support, to creating demand for these removals and building confidence for BECCS projects to be built.

5.3 DECARBONISATION IMPACT ACROSS THE WIDER UK

Alongside the emissions reduction activities across industrial facilities within the Solent region, infrastructure projects within the region could deliver opportunities for decarbonisation across the wider UK economy.

Production of **sustainable aviation fuel** (SAF) is currently being explored by ExxonMobil at its Fawley site. SAF could play a key role in achieving emissions reduction in the hard-to-abate aviation sector – the fuel can be used with existing aircraft, but on average emits 70% fewer greenhouse gas emissions. The UK Government has set a SAF mandate, requiring a proportion of all UK aviation demand to being met by SAF. This begins in 2025, and will require SAF to provide 10% of all jet fuel use by 2030 and 22% by 2040.[39] With existing direct pipeline connections to supply aviation fuel from Fawley to two of the UK's busiest airports (Heathrow and Gatwick), this could provide a significant impact on UK wider aviation emissions and support in meeting SAF mandates.

A renewable methanol synthesis plant could also be introduced into the Solent region, using captured biogenic CO_2 and green hydrogen available locally (see *Case Study: Carbon Capture at Veolia's Marchwood Facility*). This facility could produce 70,000 t/year of renewable methanol fuel. This fuel could represent a low carbon opportunity for use in the maritime sector – over 200,000 shipping movements are seen across the ports of Southampton and Portsmouth, with trade connections to ports across the globe.

However, it is noted that production of SAF and renewable methanol will need to be underpinned by the availability of low carbon hydrogen. ***Further infrastructure and hydrogen production capacity*** *will need to be developed to unlock these opportunities.*

Should large-scale **carbon capture and storage (CCS)** infrastructure be established in the English Channel near to the Solent region, this may offer a further opportunity for CO_2 to be imported for storage from elsewhere in the UK. A number of industrial facilities in the UK are likely to rely upon carbon capture to abate emissions, but in areas such as South Wales and south-east England, no appropriate geological formations for storage are available locally. There may also be potential additional opportunities to import CO_2 from mainland Europe. Based on feasibility work to date, the storage capacity for CO_2 below the English Channel is understood to be significant, supporting the opportunity for CO_2 liquefication and shipping into the Solent for permanent sequestration.

38 "*MIP 8.4: Expert workshop gives a reality check on BECCS*", IDRIC
39 "*Sustainable Aviation Fuel Initiative*", HM Government

6. WHAT THIS MEANS FOR THE SOLENT REGION

6.1 STAKEHOLDER FEEDBACK

As part of the Solent LIDP, the **University of Southampton** led work on engaging with a range of stakeholders to gain understanding of perceptions and social acceptance of decarbonisation in the Solent region. It facilitated a total of five workshops across Southampton, Fareham and the Isle of Wight, engaging with over 80 members of the public and representatives of local businesses, local authorities, community groups and academia. Specifically, these workshops sought to understand public perceptions of the decarbonisation challenge, views on key opportunities and trade-offs, and visions of a low carbon future in the region. Discussion also included perceptions of the current decarbonisation landscape and potential frameworks for the future.

These workshops introduced the work of The Solent Cluster and the Solent LIDP project, provided a background on existing decarbonisation policy and strategy, and conducted a structured engagement exercise around "plausible futures" for the Solent region. This exercise invited participants to consider trade-offs in eight key areas relevant to decarbonisation, and score these from three different perspectives:

1. **Present:** perception of how trade-offs are currently being approached *today*.
2. **Future BaU:** perception of how trade-offs will be approached in a *business-as-usual future*.
3. **Future ideal:** perception of how trade-offs would be approached in a *plausibly ideal future*.

The list of trade-offs and the two extreme positions for these trade-offs are as listed in Table 1. Participants scored these trade-offs between these extremes, on a scale between -5 and 5, for each of the three perspectives.

TABLE 1: Trade-offs and choices considered by participants during stakeholder "plausible future" workshops

TRADE-OFF	EXTREME CHOICE (-5)	EXTREME CHOICE (+5)
Who pays?	Public	Private
Decision-making and power	Central	Devolved
Jobs and education workforce transition	Incremental	Transformational
Provision of services	Private	Public
Driver of change	Market	Regulation
Greenhouse gas removals	Nature-based	Engineered
Lifestyle & public engagement	Behaviour change	Technology development
Emissions abatement	Offsets	Mitigation

Results and key findings

The data gathered from perspectives offered across these workshops is summarised across Figure 13, which highlights the range of perceptions from workshop attendees across these eight trade-offs and how these vary between **Present**, **Future BaU** and **Future ideal**.[40]

40 Further details of the full results, including detailed results of the "plausible futures" exercise by participant sector and further analysis of findings, are included in the full WP3 report.

FIGURE 13: Stakeholder workshop results, showing opinion mapping of key choices for the three perspectives.
Dots with lines show the mean response for each trade-off, with colours indicating scenario: Present (turquoise), Future: BAU (teal), and Future: ideal (navy).

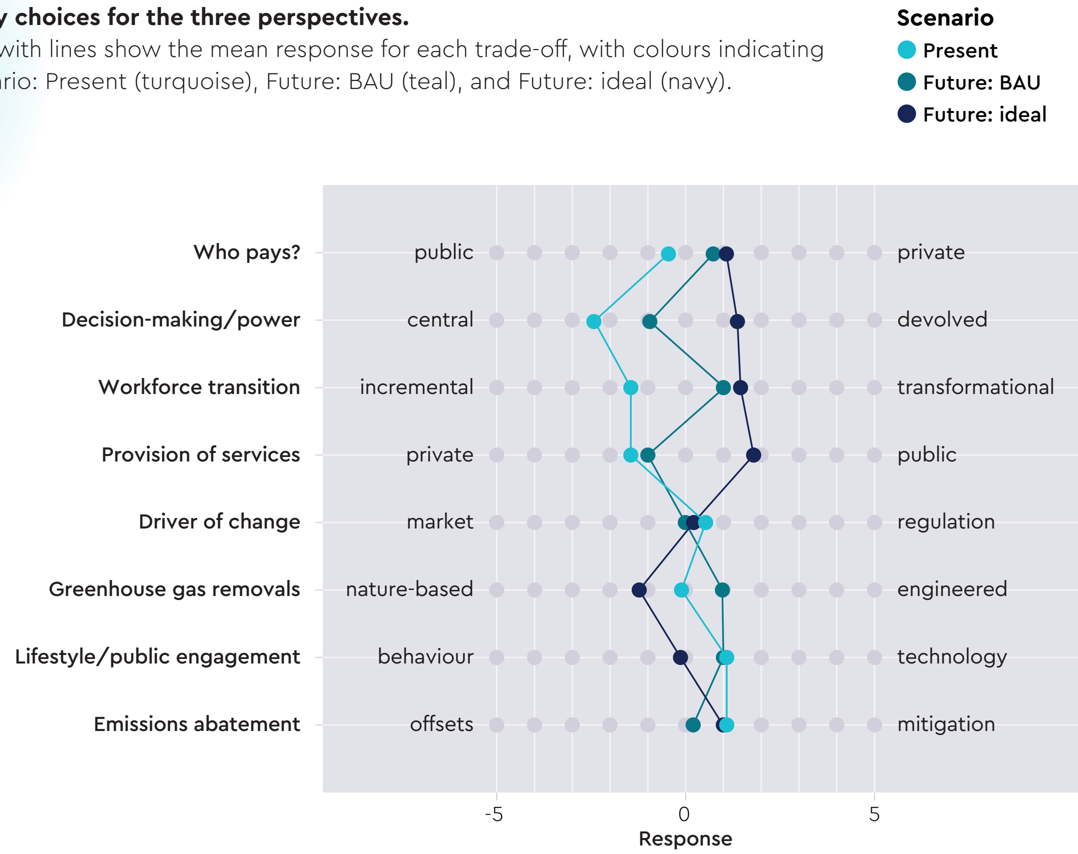


Figure 13 points to a view that **decision-making around decarbonisation is currently highly centralised**. Stakeholder perceptions see that under a business-as-usual future this may drift towards more balance between centralised and devolved approaches, but that is an ideal future, this should be more focused at a local level. If not the case, there is a **potential risk of not capturing unique aspects of local regions** and, as a result, not fully **delivering co-benefits to the energy transition**.

Stakeholders viewed the roles of the public and private sectors as largely balanced in funding decarbonisation activities and providing services in today's world. However, there was a perception across the workshops that in both business-as-usual and ideal futures, **private sector investment could play an increasingly significant role in future decarbonisation technology deployment**. This funding was anticipated to come from organisations currently representing large sources of emissions. Participants also indicated that, under a business-as-usual future, the provision of services might remain balanced between the public and private sectors, but ideally this may become increasingly driven by the public sector. This potentially points to **an ideal future with an increased role for shared decarbonisation infrastructure**, rather than reliance on action by individual organisations. Further, attendees also identified the continued role of **strong regulatory frameworks** to ensure that private sector decarbonisation activities can deliver public benefit.

Stakeholders viewed today's approaches to workforce transition as relatively incremental. However, there was a perceived need in both a business-as-usual and ideal future for a more transformational change in this area. This recognises **the potential challenge and urgency of developing new skills and workforce to deliver the shift to a decarbonised future**.

Finally, Figure 13 also indicates largely balanced views on ideal approaches in areas such as emissions abatement, greenhouse gas removals and the extent to which decarbonisation should be driven by public lifestyle behaviour change or larger-scale technology. This potentially indicates a role for a range of technologies and approaches in an ideal decarbonised future.

Key takeaways from stakeholder workshops

Engagement through the Solent LIDP process suggests that **local stakeholders in the region were not informed or engaged** with both opportunities and trade-offs associated with decarbonisation. Stakeholders emphasised across the workshops a need to ensure that the focus of industrial decarbonisation remains not just on emissions reductions but instead also incorporates **consideration of local economic benefits and just transition aspects**. There is a clear case for continuing to involve these groups as industrial decarbonisation strategy develop to increase local buy-in, build trust that co-benefits will be delivered, and ensure decisions adequately consider local context.

The evidence gathered suggests **an overall preference to move towards a future with the public and private sectors working in partnership**. Decarbonisation can be achieved through a range of technologies and approaches, supported by shared public infrastructure and with private organisations encouraged to collaborate, engage locally to gain local perspectives, and build trust.

6.2 SOCIO-ECONOMIC BENEFITS TO THE SOLENT REGION

With industry across Solent region currently emitting over 5 million tonnes of CO_2 annually, the region's economic activities are closely tied with its greenhouse gas emissions. Decarbonisation projects seek to decouple the continued industrial activity from these carbon emissions, in addition to growing activities into new green industries of the future.

These projects are likely to drive significant investment in decarbonisation technologies within the region – this investment in turn can deliver **economic benefits and job creation for both the Solent region and the wider UK**.

Economic growth and job generation

Socio-economic modelling has been undertaken to quantify the economic impact that may be driven within the Solent region, both directly and along the supply chain.[41] This analysis focuses upon the impacts that could be delivered by three potential infrastructure and decarbonisation projects in the region which, if built, would represent major sources of local investment:

- **Carbon capture equipment** at Veolia's Marchwood ERF; [42]
- **CO_2 storage in the English Channel**, with a potential connecting pipeline;[43] and
- **A potential SAF production plant**[44] connected to existing aviation fuel pipelines to Heathrow and Gatwick.

As discussed below and shown across Figure 14 and Figure 15, these projects were highlighted because they could deliver significant economic value and job creation. The overall socio-economic benefits from decarbonisation to the Solent region could be greater still with other infrastructure developments also anticipated to be required to achieve decarbonisation in the Solent region, including hydrogen production and electricity grid upgrades. Additionally, on-site investment in decarbonisation technologies decarbonisation projects in new low carbon industries, such as maritime fuels, will introduce additional investment and economic benefits.[45]

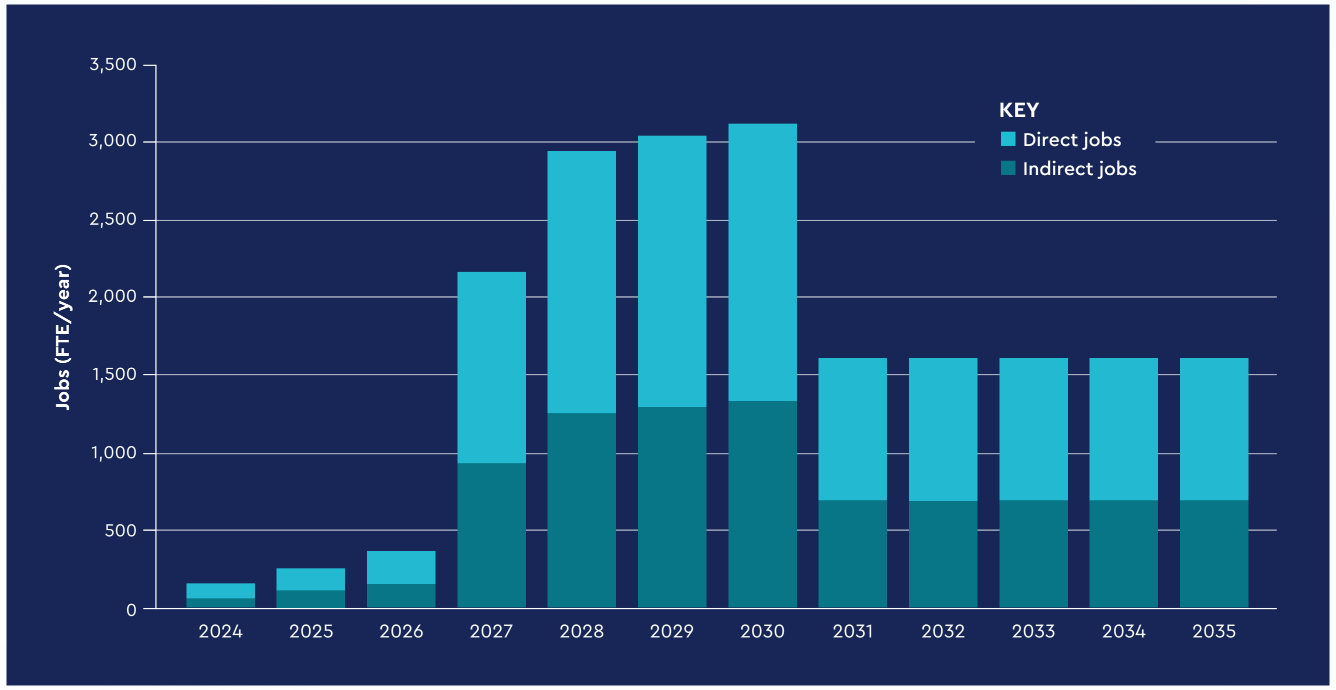
Within the Solent region, the adoption of these three projects could create **more than 3,200 additional jobs**,

41 Best estimates of cost requirements and deployment timelines are used, based upon engagement with project proponents and values from literature.
42 The project at the Marchwood ERF refers only to the installation of carbon capture equipment, and does not include any investment in supporting infrastructure for CO_2 transport and storage.
43 Local CO_2 storage to the Solent region and a potential pipeline is treated as a prospective project, given the halting of plans to develop this by ExxonMobil.
44 SAF production is likely to require both captured CO_2 and low carbon hydrogen for synthesis into fuel. Carbon capture at Marchwood would represent one potential source of this CO_2. Hydrogen may be supplied from local production projects or sourced from elsewhere in the UK, for example through Project Union or H2 Connect. Infrastructure for additional CO_2 sources and hydrogen production are not included in the scope of the socio-economic analysis presented here.
45 Detailed analysis within WP4 reporting has also considered the socio-economic impacts that could be associated with on-site decarbonisation activities by a number of sites in the Solent region and other potential projects such as a renewable methanol production plant and two green hydrogen production plants.

at the peak of construction (see Figure 14). 57% of this employment would be direct jobs in developing and constructing these projects, with the remaining 43% arising indirectly across the project supply chain. Many of these job requirements would be anticipated to then later transition to permanent operational and maintenance roles.

These created jobs are in addition to any employment that may be safeguarded by decarbonisation activities. Industrial facilities in the Solent region currently provide employment for thousands of people.[46] Projects that allow these sites to decarbonise and continue to operate as low carbon facilities into the future will protect the Solent region from potential job losses.

FIGURE 14: Gross annual jobs generated through delivery of the three highlighted projects within the Solent region



As per Figure 15, these projects could contribute **£2.7 billion in Gross Value Added (GVA)** to the UK economy by 2035. A large portion of this would be within the Solent region – to ensure that local economic benefits are retained in the Solent region, working with local suppliers for key materials for decarbonisation projects wherever possible should be prioritised.

Future opportunities in supplying low carbon fuels

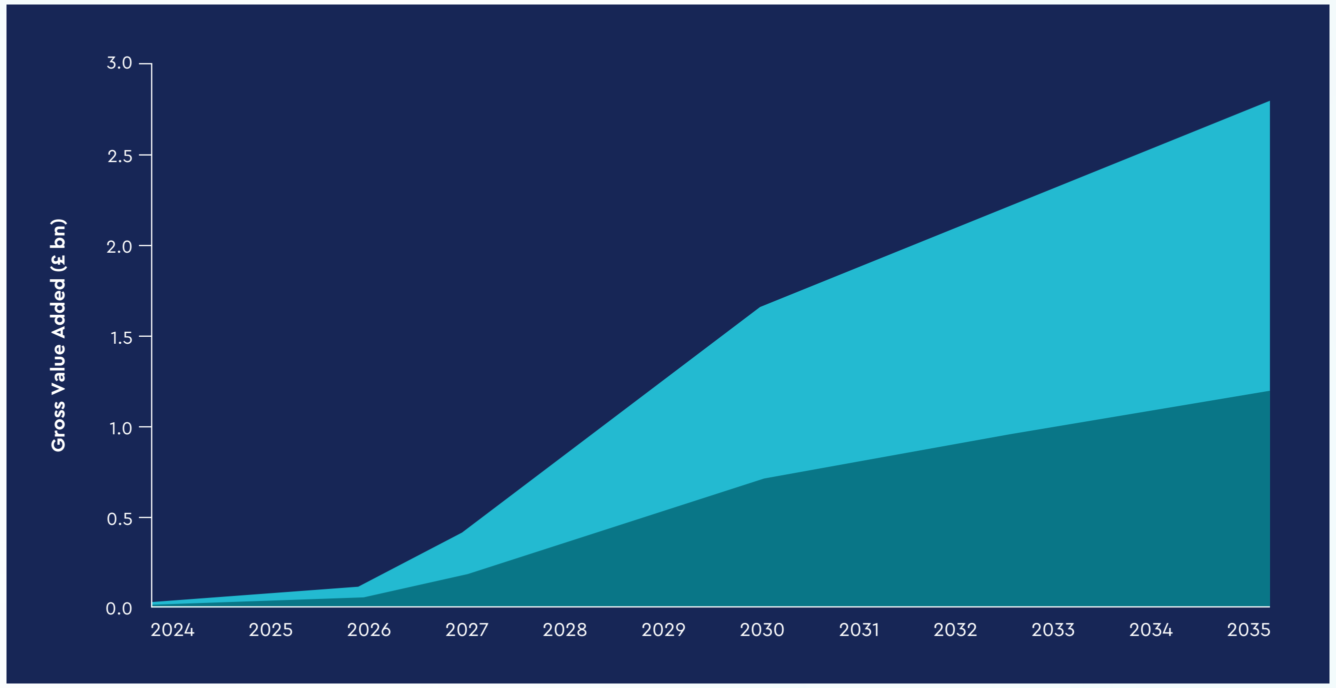
The Solent region is strongly placed to drive decarbonisation of both existing industry in the region, but also across the wider UK, in key sectors such as aviation and shipping. Maintaining and growing these sectors while reducing emissions is critical to the UK meeting its Net Zero commitments, while remaining internationally connected and growing trading with partners across the globe. The size of these opportunities in the Solent region could be considerable, and fully harnessing these through a SAF production plant included above and additional projects could drive significant additional economic opportunities.

The Solent region hosts two of the UK's largest ports, located near to the world's busiest shipping routes, such as between Rotterdam and Shanghai. As a result, the ports are a key hub and gateway for trade between the UK, and European and global markets – the ports of Southampton and Portsmouth together see over 200,000 large vessel movements and £77.5 billion in goods imports and exports each year.[5, 7]

Driven by the large number of vessels and often long-distance shipping from these ports, it is estimated that around 30% of all UK shipping fuel consumption is from

46 For example, the Fawley Petrochemical Complex currently provides employment for 2,500 staff and contractors.

FIGURE 15: Cumulative gross value added through delivery of the three highlighted projects within the Solent region



vessels entering the ports of the Solent region.[47] In 2022, shipping activities in the UK contributed a total 11.6 $MtCO_2e$, highlighting the significant impact that supply of low carbon maritime fuels could drive in the region.[48] Low carbon hydrogen production in the Solent region, and the production of maritime fuels such as renewable methanol, therefore represent clear opportunities for the region.

The port of Southampton was the first port in the UK to introduce a commercial shore power unit, supporting its role as Europe's leading cruise port. ABP have recently partnered with Plug and Play to launch an Energy Ventures Accelerator initiative, with Southampton selected as the focus for maritime decarbonisation.[49] Portsmouth International Port aims to be the first UK port with Net Zero operations and is introducing a range of initiatives to lower its carbon emissions, including solar power and its Sea Change project.[50] In addition, the University of Southampton has an ambition to establish a global centre of excellence for maritime decarbonisation - with its Centre for Green Maritime Innovation.[51]

The Solent region already plays a significant role in the UK aviation sector – the Fawley Petrochemical Complex is a major provider of aviation fuel in the UK. Aviation fuel is supplied by direct (and recently upgraded) pipeline from Southampton to Heathrow and Gatwick, the UK's two busiest airports.[52]

From 2025, the first stage of the UK Government's "Sustainable Aviation Fuel (SAF)" mandate will come into place. This is a key policy that will require 2% of total UK jet fuel demand to be met with lower carbon alternatives to traditional fossil aviation fuels. This mandate is then to increase linearly to 10% in 2030 and to 22% in 2040.[42] The Solent region is well-placed to play a major role in the production and supply of this low carbon aviation fuel, making it an excellent location for SAF production facilities, given the existing infrastructure. This would also include supporting infrastructure such as low carbon hydrogen production and existing pipeline connections for fuel supply.

47 Data from Verschuur, J. (2024). Maritime fuel demand projections for the year 2050 at 1377 global ports. NERC EDS Environmental Information Data Centre. Estimate here based on dataset modelling of fuel consumption by port in 2015.
48 Data from UK Government "*Transport energy and environment: data tables*". Values include emissions from domestic and international aviation and shipping. Emissions from international shipping only includes journeys with a starting point in the UK.
49 "*ABP and Plug and Play launch sector-leading Energy Ventures Accelerator*", ABP
50 "*Sea Change*", Portsmouth International Port
51 "*Centre for Green Maritime Innovation*", University of Southampton
52 Airport business defined by number of annual aircraft movements.

The emissions reduction impact driven by the Solent region could be significant – in 2022, UK aviation contributed emissions of 29.6 MtCO_2e.[52] From both Heathrow and Gatwick, over 700,000 aircraft movements are seen annually, representing more than a quarter of those in the UK as a whole.[53] With aviation traffic at these major London airports including larger aircraft and longer haul routes, production of SAF in the Solent region has the potential to abate over a fifth of all UK aviation emissions.[54]

Skills development

Increased uptake of decarbonisation technologies is anticipated to drive needs for new skills in the Solent region's workforce. Industrial decarbonisation will require professional skills in areas such as heat pump installation and construction of larger scale infrastructure projects. Wider decarbonisation activities will also introduce needs for jobs in areas such as low emissions transport – for example installation and servicing of electric vehicle (EV) charge points.

These roles of the future will require a range of skillsets in the workforce. The construction sector is one sector likely to play a key role in many projects, with new positions potentially appropriate for those with limited previous training and accessing apprenticeships. Other roles such as in architecture, engineering and head office roles are likely to require more formal education and specialist training.

The existing network of colleges and universities in the Solent region is likely to be well-placed to deliver training for specialist skills.[55] However, understanding the future skillsets and workforce requirements to deliver decarbonisation will be crucial so that appropriate skills are available in the workforce, as they are needed in a future. Continued collaboration between education institutions, industry and local government – as is already happening as part of initiatives such as the Solent Local Skills Improvement Plan (Solent LSIP) – will be crucial to ensuring skill availability meets workforce needs in future.[56]

Education and job opportunities should also seek to ensure that green jobs of the future are open and accessible to people of all races, ethnicities, religions, abilities, genders, and sexual orientations. Many groups are under-represented in the workforce and this disparity is even more pronounced in many of the sectors most relevant to the energy transition. However, a workforce that incorporates a wider range of backgrounds and perspectives can only improve outcomes and innovation. Diversity, equality and inclusion should be a priority across hiring practices, alongside to ensuring equal opportunities to access education and building skills in people across all backgrounds.

53 Data from Civil Aviation Authority *"Annual airport data 2023"*
54 It is assumed that SAF emissions are 70% lower than of traditional fossil jet fuel.
55 *"Solent LEP Low Carbon Skills Report"*, Gemserv
56 *"Solent LSIP"*, Hampshire Chamber of Commerce

7. KEY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The Solent region is one of the largest industrial regions in the UK, with current annual emissions totalling over 5 million tonnes CO_2e and it is strategically located with port infrastructure and connections to the wider UK. The region hosts a diverse range of industries, with the most significant facilities clustered around Southampton, particularly to the west of the city.

This Solent LIDP project indicates that the region could be transformed into a deeply decarbonised cluster, while delivering regional economic growth and generating new employment opportunities. However, **delivering deep decarbonisation in the Solent region will require significant action**. Under a business-as-usual trajectory, it is estimated that the region will fall significantly short of Net Zero, with industrial scope 1 and 2 emissions in the region potentially **reducing by just 7% between 2023 and 2050**. Analysis across the project has identified key priority areas for decarbonisation, with co-located infrastructure likely to be critical to delivering these.

Modelling undertaken as part of this work identifies a clear need for **carbon capture** to decarbonise existing industry within the Solent region. Further opportunities could be unlocked through CCS deployment in the region, such as the import of CO_2 from other industrial regions with limited access to CO_2 sequestration or achieving greenhouse gas removals, such as BECCS. Locations in the English Channel near to the Solent region are geologically suitable for this, with ExxonMobil having previously developed plans to develop CCS infrastructure in the region. However, with progress on this project paused in autumn 2024, the future of this infrastructure locally remains uncertain. In light of this uncertainty, other options for carbon transport and storage to other CO_2 stores in the UK, such as shipping or rail, are under consideration.

Low carbon hydrogen is likely to be key for industrial emissions reductions via fuel switching, in particular to replace current use of natural gas. Additionally, there is growing demand for renewable fuels across other sectors such as aviation and shipping – for which hydrogen would represent a crucial feedstock. The Solent region contains major port infrastructure and pipelines to supply aviation fuels to major UK airports, and so is well placed to harness major opportunities to supply these renewable fuels. Aviation and marine emissions were not in scope of this study and should continue to be explored by organisations such as Maritime UK Solent. Potential for local hydrogen production and integration with wider infrastructure development – such as Project Union, H2 Connect and major hydrogen storage at Portland – should continue to be explored to support decarbonisation of current industry and launch new low carbon industries.

As the UK's electricity supply continues to decarbonise, there is anticipated to be a **growing demand for electricity** for industrial process electrification, green hydrogen production and across other sectors, such as ports. At smaller sites, process electrification may be achievable within current infrastructure – however, the electricity network in the Solent region is already highly constrained, so is likely to require reinforcement to fully support decarbonisation. Further analysis into future electricity consumption across industry and other sectors is therefore critical, with investment needing to be prioritised for the most constrained points on the network.

In addition to major projects potentially unlocked by infrastructure development, some facilities may also be able to achieve near-term emission reductions through **energy and resource efficiency levers**. These can often be deployed in the immediate term, without reliance upon wider infrastructure, and can also offer operating cost savings. Concrete and innovative examples of potential projects have been identified by industrial members of the Solent LIDP, and effective knowledge-sharing between businesses could accelerate deployments.

The concluding section to the Solent LIDP report sets out steps towards realising these decarbonisation and growth opportunities. This is split into two sections:

- **Key activities and projects** which will be required in the Solent region to achieve decarbonisation, protect current jobs and generate economic growth.
- **Key near-term actions** from both The Solent Cluster and other organisations to enable and unlock this potential.

7.1 TRANSITIONING PATHWAYS TO A DECARBONISED SOLENT

This Solent LIDP project highlights that there is **a clear need for further decarbonisation projects and anchor infrastructure in the Solent region**. Moreover, additional projects could drive decarbonisation opportunities beyond the region, supporting industrial decarbonisation across the wider UK, and growing the local economy.

Transitioning pathways to a decarbonised Solent must therefore focus on four key distinct but interconnected areas to progress existing projects and identify priorities for new investment.

1. **Near term emission reductions:** The many industrial sites dispersed across the Solent region have **opportunities to continue some decarbonisation in the near term**, without reliance on significant wider infrastructure. Emission reductions can be achieved through energy efficiency measures and equipment upgrading/retrofits; these represent "no-regret" activities but support may be required to identify and implement them.
2. **Major decarbonisation projects and anchor infrastructure:** To achieve deep decarbonisation, **large abatement projects are critical at the highest emitting sites in the region**, such as the Fawley Petrochemical Complex and Marchwood Energy Recovery Facility. **Anchor infrastructure** can unlock decarbonisation opportunities for these sites in three main areas: low carbon hydrogen, CCS, and electricity network reinforcement.

   Collaboration and support to develop both on-site projects at the largest emitting facilities and the anchor infrastructure will be **crucial to the Solent region**.
3. **Further energy transition opportunities:** The Solent region can utilise its unique position in having extensive port infrastructure and pipeline connections to major airports, to develop projects in green innovation, manufacturing and low carbon fuels. Projects could include production of hydrogen for industry, renewable methanol as maritime fuel and sustainable aviation fuel. These can drive **decarbonisation opportunities across other sectors and the wider UK** and provide further economic growth locally.
4. **Government policy direction and private investment:** The Solent Cluster Transitioning Pathways Report provides a vision and the potential directions to achieve a decarbonised lower carbon industry in the Solent. To advance projects, both national government policy direction, funding and private investment are essential. The options outlined in this report need further development and expansion to ensure projects are ready to proceed once these policy and investment conditions are met.

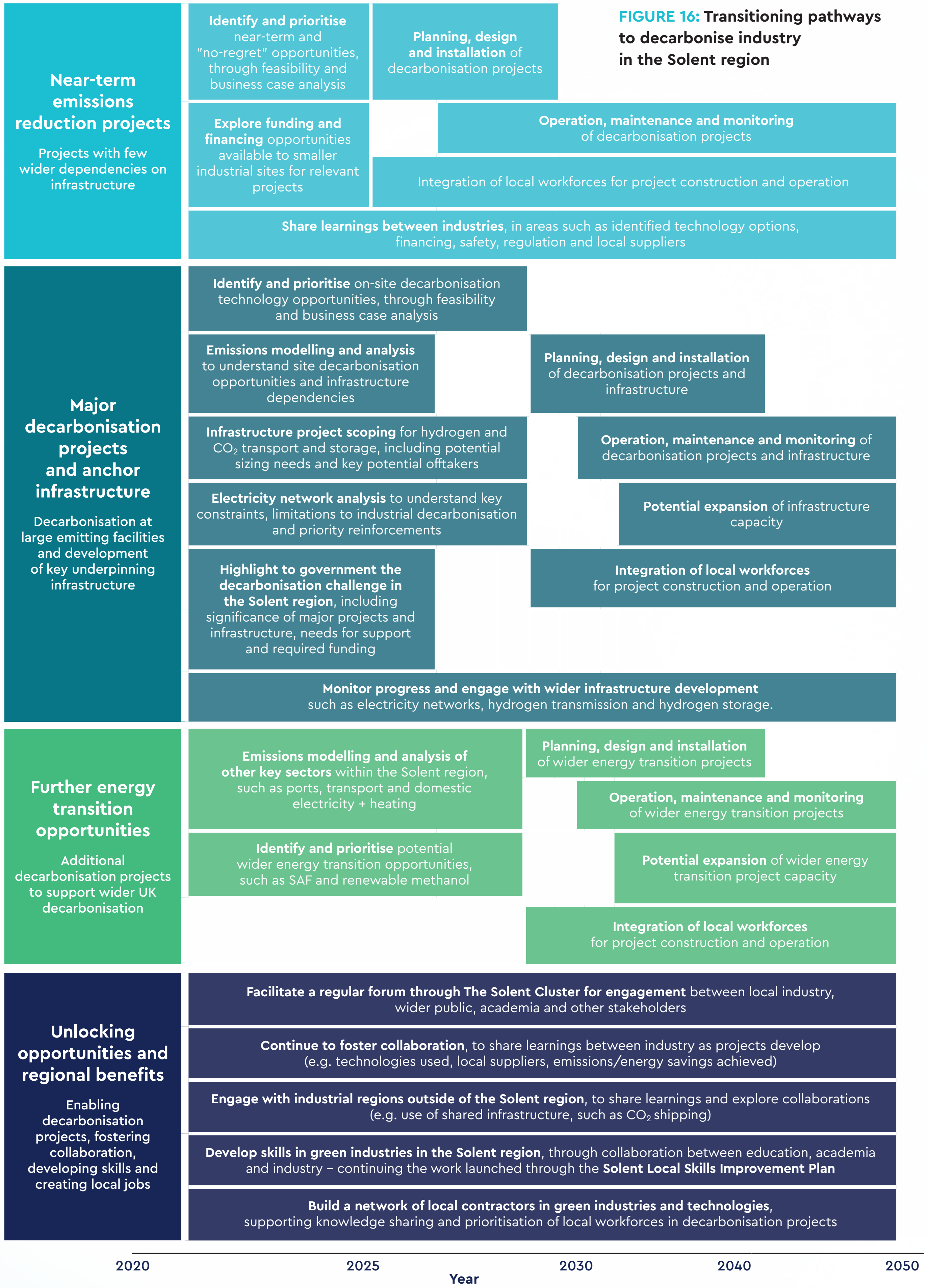
To progress across all three of these areas, a range of underlying activities are required to unlock project opportunities and regional benefits. These activities will engage and foster collaboration between industry, education institutions, the public sector, policymakers and the wider public.

Additionally, this report demonstrates the need for further engagement with the public and key stakeholders to ensure the societal benefits are understood and there is public support for change.

The activities are focused upon building local skills in industries of the future, supporting local workforces, sharing learnings as decarbonisation projects develop, and ensuring that local stakeholders and the wider public continue to support progress towards a decarbonised future.

An outline of key activities to decarbonise industry in the Solent region and realise these opportunities is presented in Figure 16. The Solent LIDP projects represent the first stage of many of these activities and actions.

FIGURE 16: Transitioning pathways to decarbonise industry in the Solent region



7.2 NEXT STEPS

To realise this regional vision, The Solent Cluster recognises both its own role in fostering collaboration and coordinating progress towards a decarbonised Solent region, alongside the need for wider action and support to deliver necessary projects.

7.2.1 A role for The Solent Cluster

The Solent Cluster is an existing initiative in the Solent region, bringing together private and public sector organisations and fostering collaboration towards a shared vision of a decarbonised industrial region, protecting current jobs and driving new employment opportunities. The Solent Cluster should be sustained as the lead, industry-led body to convene and connect the region, coordinate collective activity and advocacy, to provide a central point through which to engage with government, to share knowledge and build collaborations, including for funding and research.

Having led the development of this Solent LIDP project, The Solent Cluster is well-placed to continue to drive progress towards a shared vision and has identified a set of priority actions planned to enable this beyond the Solent LIDP project:

FIGURE 17: Priority next steps for The Solent Cluster

1 **Lead dissemination activities** on outcomes from the Solent LIDP project, and beyond.

2 Continue to act as a **coordinating body and forum** for collaboration and knowledge-sharing between industry

3 Support continued development of regional **technical analysis** and **data monitoring**.

4 Continue to **foster collaboration between industrial and education sectors** to identify future skill needs and training opportunities

1. **Lead dissemination activities on outcomes from the Solent LIDP project, and beyond.** Work in this project has identified a clear need to engage with the wider public around decarbonisation planning, to ensure local buy-in and gain local insights.
    - Deliver a launch event to showcase and disseminate work carried out in the Solent LIDP project.
    - Schedule and advertise regular events for communication between local industry, the wider public and other stakeholders in the Solent region. This will include at least six events per annum, convening at least 300 people from across industry in the Solent. Such events will not only socialise new vocabulary and create a better understanding of decarbonisation issues, but provide technical expertise and case studies to enable attendees to make their own decarbonisation journey. These will also act as a forum for providing updates on project progress and invite contributions from stakeholders in the region.
2. **Continue to act as a coordinating body and forum for collaboration and knowledge-sharing between industry – both for industries locally and across the UK.** Analysis indicates a key role for shared infrastructure projects and for sharing of learnings as decarbonisation projects are developed.
    - Continue to host regular events for engagement between local industry in the Solent region.
    - Develop a platform for the sharing of detailed data and learnings between organisations, as decarbonisation projects are identified and then implemented. Organisations will be invited to provide details such as technology options; metrics of achievable emissions reduction and/or business case considerations; local supplier and workforce availability; and successes or setbacks experienced during implementation.
    - Examples of decarbonisation project identification and knowledge sharing are included in this report from Veolia, GEO Specialty Chemicals, Enoflex and StandardAero.
    - Lead engagement with other industrial clusters in the UK, on behalf of the Solent region. This can further support knowledge sharing to mutual benefit regional industries and may identify opportunities for use of shared infrastructure, such as CO_2 shipping.
    - Establish and manage working groups that report to The Solent Cluster Board across:
        - Near term emissions reductions
        - Major decarbonisation projects and anchor infrastructure
        - Further energy transition opportunities.
3. **Support continued development of regional technical analysis and data monitoring.** Continuing to develop data-driven tools and produce up-to-date numerical analysis will allow monitoring of regional progress towards deep decarbonisation, support wider investment and unlock collaboration with other sectors.
    - Develop further analysis of emissions and decarbonisation opportunities in the Solent region, including port activities, transport emissions associated with industry and interactions with the electricity and natural gas networks.
    - Regularly collate regional industrial emissions and develop a public-facing mapping and emissions tracking dashboard.
    - Develop a more detailed dashboard available to regional partners, showcasing progress of emissions reductions against modelled decarbonisation scenarios. Data may also facilitate collaboration between industrial sites and infrastructure developers, for example for knowledge-sharing or identifying shared project opportunities.
    - Seek further funding for and support additional analysis across other key project areas, such as:
        - A study to establish the required marine infrastructure and dredging to enable CO_2 shipping from Marchwood Industrial Estate, as well as pilotage simulation.
        - A study to understand the infrastructure requirements to establish a rail hub for the transportation of CO_2 captured in the Solent region by rail and/or the receipt of carbon captured elsewhere for onward transportation by shipping.
        - Projects for research, testing and commercialisation of sustainable decarbonisation solutions and clean maritime technologies through the University of Southampton's Sustainability and Resilience Institute and planned Centre for Green Maritime Innovation.
4. **Continue to foster collaboration between industrial and education sectors to identify future skill needs and training opportunities.** Decarbonising the Solent region through technology development, while ensuring local economic growth, will require new and existing skills to be developed within the region.
    - Encourage and provide supporting resources for industrial facilities and infrastructure developers to consider skill needs to deliver decarbonisation projects.
    - Continue to host skills-focused networking events and progress activities identified through the Solent Local Skills Improvement Plan. Facilitating opportunities for industry to share insights around future workforce needs with education can allow appropriate training courses to be developed and delivered.

- Promote diversity, equality and inclusion as a priority across admissions to training courses, training opportunities and hiring practices.

7.2.2 Recommendations to unlock industrial decarbonisation in the Solent region

Achieving this vision of a decarbonised and prosperous Solent region will also require external action, engagement and support. Recommendations and actions for key parties to achieve this vision are identified below.

Government and policymakers

- **More focus is needed on Industrial Clusters outside of Track 1 and 2**, particularly those currently taking part in the Industrial Decarbonisation Challenge.[2] The Solent Cluster is one of the largest clusters outside of Track 1 and 2 based on Scope 1 and 2 emissions, at greater than 5 $MtCO_2e$/year, and expansion of industrial policy support to include greater focus on the Solent and other medium-sized industrial regions would accelerate critical infrastructure in these regions and help address regional inequality.
- **Further clarity is needed on government support for major infrastructure projects, such as CCS and hydrogen production.** Analysis in this project has identified a clear need for new infrastructure to underpin facility decarbonisation projects. Major sites in the Solent region, such as petrochemicals and energy recovery facilities, have no realistic means of decarbonising without the use of carbon capture and, in the absence of CO_2 transport and storage infrastructure, over 3.8 $MtCO_2e$ may remain in annual industrial emissions by 2050. Similar challenges are anticipated if low carbon hydrogen availability is limited in the region.

  Additionally, the business case for such projects remains challenging without government policy support – as seen, for example, through the recent halting of ExxonMobil's CO_2 transport and storage project plans for the English Channel. Clarity around future government policy would provide further certainty and reduce risk for these projects to progress.
- **Introducing further policy support for electrification and energy efficiency** measures could unlock opportunities, particularly for smaller industrial sites that could electrify processes with heat pumps, e-boilers, etc., and thermal energy storage within current network constraints. This support could include electrification business models which may be necessary to allow some sites to offset the increased comparative cost of electricity versus natural gas.
- **Offering additional support for non-pipeline transport of** CO_2, such as by rail or shipping, could unlock CCS as an abatement opportunity for a greater number of industrial sites in the UK. With strong rail and port infrastructure, the Solent region could offer access to CO_2 storage infrastructure to dispersed sites and those with otherwise limited access to nearby CO_2 stores. The Government has recently launched both a call for evidence and ETS consultation around the future NPT of CO_2. This needs to be accelerated to provide clarity to clusters and emitters which may rely on NPT to store captured CO_2.
- **Continue to monitor relative system costs of electricity network upgrading versus increased hydrogen use** to inform infrastructure priorities. Analysis in the Solent LIDP has identified significant limitations to regional industrial decarbonisation, due to both existing grid constraints and currently limited access to low carbon hydrogen. A portion of industrial emissions could however be abated by either electrification or fuel switching, meaning that system-wide considerations could inform future infrastructure priorities, business models and available policy support.

Local industrials in the Solent region

- **Identification of projects with limited dependency on wider infrastructure should be prioritised for implementation in the immediate term.** Projects such as process improvements, energy efficiency measures and some process electrification could be implemented as near-term, "no-regret" measures. Exploring potential opportunities, carrying out business case assessments and progressing with the most promising will allow early emissions abatements to be achieved. Organisations may also make operational cost savings by operating with reduced energy consumption.
- **Exploring technology options and potential deployment of major on-site decarbonisation projects** should be considered as early as possible, especially for high-emitting sites with limited alternative technology pathways to decarbonisation. With emissions in the Solent region dominated by a small number of major point emitters, implementation of these projects will be crucial to decarbonisation in the Solent region. Carrying out feasibility studies and analysis at an early stage will provide improved visibility on potential project costs and dependencies upon infrastructure, which in turn can inform potential needs for financial support and infrastructure sizing requirements.
- **Learnings as decarbonisation technology projects are identified and deployed should be shared and communicated** with other local industry, for mutual benefit. Sharing details such as technologies considered and outcomes of any business case or feasibility assessments could allow other organisations to identify opportunities and accelerate uptake of similar solutions, where suitable. The Solent Cluster provides an ideally placed vehicle for this dissemination. Experiences from project deployment, including both successes and setbacks, can allow future similar projects to be deployed more effectively and efficiently. Moreover, where enabling technologies are manufactured locally and contractors are based within the Solent region, this can also be highlighted and support local economic growth. The Solent Cluster proposes to develop a forum by which these learnings can be efficiently shared.
- **Engagement with the public should continue**, as decarbonisation plans and projects develop. A clear focus of all decarbonisation activities in the Solent region is to ensure that the benefits of a transition to a green economy are shared across society. Forums such as those facilitated by The Solent Cluster offer opportunities for industry to build public awareness of planned decarbonisation activities; invite feedback on local context and considerations; and develop social acceptance for a path forward.
- **Development of local skills and integration of local workforces** includes a key role for local industry. As decarbonisation projects are developed, consideration should be given to the skills required for construction and operation of new equipment. Engaging with skills forums facilitated by The Solent Cluster and communicating future workforce needs to the education sector can allow appropriate training courses to be launched or expanded in the region.

  As decarbonisation projects are implemented, prioritising employment of local workforces and contractors where possible will continue to drive local economic growth.

Infrastructure developers and new entrants to the region

- **The Solent region represents a key investment opportunity for new project and anchor infrastructure developments.** The Solent LIDP project has identified a clear need for new infrastructure to achieve deep decarbonisation of industry in the Solent region, with a number of sites having limited alternative pathways to reduce emissions. Such facilities are therefore well-placed to act as key offtakers for anchor infrastructure. Proximity to ports and shipping routes could unlock wider access to this infrastructure from demand elsewhere in the UK. Close engagement with major industrial facilities, operators of existing infrastructure and wider stakeholders can help to drive forward these opportunities.

  The Solent is home to major ports at Southampton and Portsmouth, and the proximity of the Port of Southampton to potential future maritime fuel production facilities, coupled with the volume of traffic across a range of trades, provides an unparalleled opportunity for integrating infrastructure to decarbonise maritime operations and shipping. ABP and Plug and Play have collaborated on an Energy Ventures Accelerator to help promising start-ups scale their businesses in high-growth energy sectors, such as hydrogen, floating wind and low-carbon fuels. Southampton has been identified as their focal point for maritime decarbonisation – recognising the innovation that exists locally and the significant port operations through Southampton. In addition, the University of Southampton is developing plans for a Centre for Green Maritime Innovation – with quayside and in-land facilities to test and commercialise clean maritime technologies and establish the Solent as a global centre for clean maritime innovation.

- **Further analysis to understand the impacts of electricity network constraints on industrial decarbonisation** will be required to unlock decarbonisation opportunities across the region, such as process electrification. The electricity network is already highly constrained in the Solent region. This poses challenges to industrial sites seeking to electrify processes, as well as other sectors which may introduce additional power demand in coming years, such as ports and data centres.

  Analysis of the electricity network should closely consider potential growth in industrial demand at specific points on the network. A phased approach of network reinforcement should then be undertaken to target and prioritise urgent constraints that may otherwise prevent industrial decarbonisation in the immediate term.

- **Provide further clarity on wider UK low carbon infrastructure projects**, such as Project Union and H2 Connect. Stated plans for these projects currently see interconnection with the Solent region, and modelling analysis suggests that the low carbon hydrogen supplied could play a key role in decarbonising the Solent region. However, uncertainty remains around these projects such as timelines and project scales. Providing improved clarity would allow local players in the Solent region a firmer basis for local infrastructure development, such as volumes of hydrogen that may need to be produced in the region.

- **Identification of barriers to delivery of infrastructure projects** can allow further collaboration with industry in the Solent and policymakers, accelerating progress towards emission reductions. Studies to quantify potential demand locations and magnitudes for these infrastructure projects can reduce risk to project developers.

The Solent Cluster is the only industrial cluster organisation in the south of England and is recognised by the Government as one of the UK's leading industrial cluster organisations. We have forged strong relationships across the business and research base, academia and the public sector, as well as with central government and industrial clusters across the UK. We want The Solent Cluster to provide a vibrant ecosystem, with a diverse membership of large, small and micro businesses, research institutions, skills institutions and other organisations, as we recognise that diversity enhances collaboration and knowledge exchange. These businesses and stakeholders are critical to the future success of the Cluster. To get involved, contact The Solent Cluster team at info@thesolentcluster.com or find out more at www.thesolentcluster.com.

APPENDIX A

BASELINE EMISSIONS DATA AND DEVELOPMENT OF THE BUSINESS-AS-USUAL FORECAST

Baseline emissions for industrial facilities in the Solent region in 2023 are quantified for scope 1 emissions (direct greenhouse gas emissions) and scope 2 emissions (indirect emissions associated with the purchase of energy and result from a company's energy consumption for its operations).

From this baseline, business-as-usual (BaU) scenario forecasts for scope 1 and 2 emissions have also been developed. These have been defined as emissions trajectory forecasts that only consider committed projects and conservative decarbonisation projections (i.e. excluding any decarbonisation initiatives identified as part of this work). Full assumptions for this BaU forecast are included in the sub-sections below.

Although analysing regional Scope 2 emissions is not typically standard practice due to inevitable double counting of scope 1 power generation emissions, the main objective was to analyse regional electricity consumption and associated indirect carbon emissions. This analysis allowed for the establishment of a baseline and BaU scenario for scope 2 emissions for reference, and provides a comprehensive view of the Solent region's carbon footprint from energy consumption. This data is essential for assessing each decarbonisation lever, such as process electrification and the energy required for carbon capture or hydrogen production.

SCOPE 1 EMISSIONS

Scope 1 emissions are direct emissions from sources that organisations directly own or control (such as fuel combustion). This does not include consumption of electricity (see Scope 2 emissions below).

Scope 1 emissions data was collected using information received from industrial entities in the region, the UK Emissions Trading Scheme registry (UK ETS)[57] and National Atmospheric Emissions Inventory (NAEI)[58].

Where possible, the most recent reported year was used in the baseline construction for 2023. However, if significant year-on-year variations were observed in the last few years, an average value was used to ensure a consistent baseline for the industrial emitter.

Business-as-usual assumptions:

- For the power generation sector, a 4% production decrease rate from 2040 onwards was assumed for gas power plants, as a conservative scenario reflecting a lower demand for fossil thermal generation of electricity but starting only in the long-term. No hydrogen blending for the power generation sector was assumed, as no low-carbon hydrogen projects or infrastructure have been committed to date.
- A flat rate was assumed for the majority of industrial emissions from 2023 to 2050, given no significant changes in production. It was also assumed that a slight increase in production can be compensated by energy efficiency measures, and no major switch to clean energy is modelled under the BaU scenario.

57 "*UK ETS Public Reports*", UK Government
58 "*Data*", National Atmospheric Emissions Inventory

SCOPE 2 EMISSIONS

Scope 2 emissions are indirect emissions associated with the purchase of energy and result from a company's energy consumption for its operations. In this analysis, the focus is upon purchased electricity, which constitutes the majority of Scope 2 emissions across all commercial and industrial sectors in the Solent region.

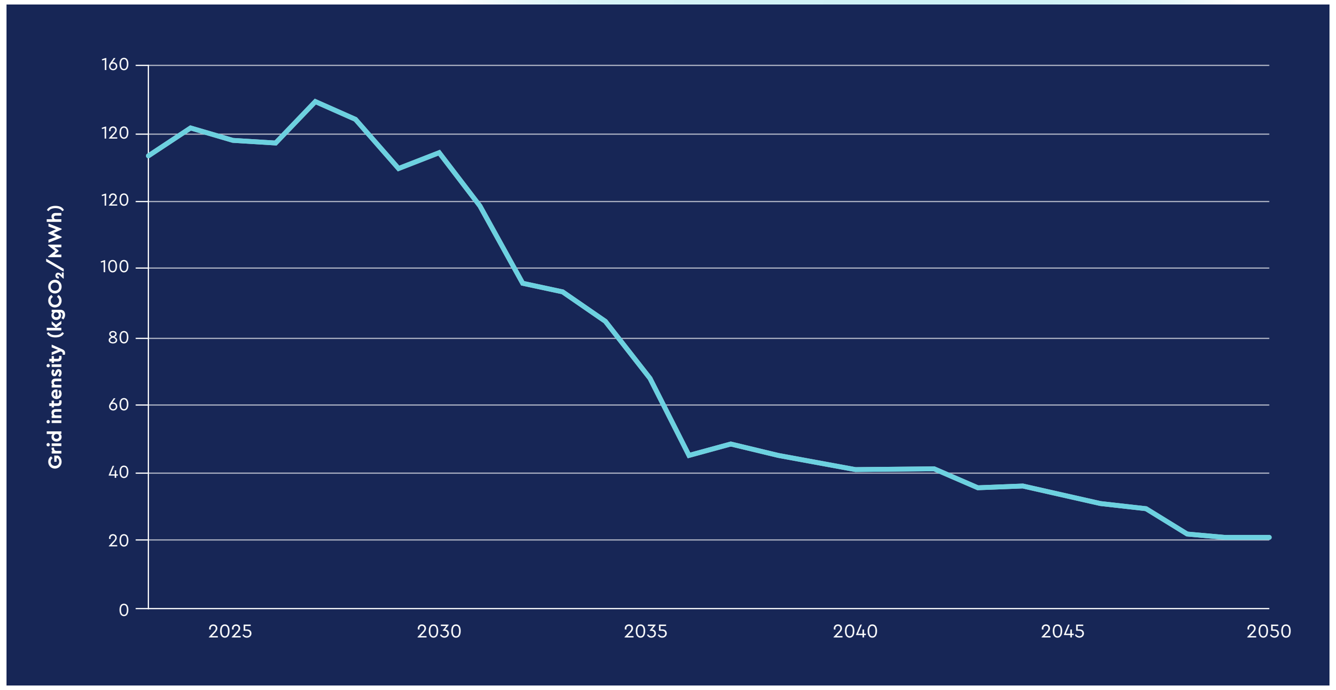
Scope 2 emissions data was collected from the 2024 National Grid Future Energy Scenarios (FES) database, which provided sufficient granular data to scope the electricity consumption of industrial entities in the Solent region.[59, 60] The selected criteria within this database included:

- Grid Supply Points (GSPs): Nursling, Fawley, Botley Wood and Lovedean;
- Types of electricity consumption (categorised as 'Building Block ID numbers'): non-domestic demand and Industrial & Commercial (I&C) heat pump demand;
- 'Counterfactual' pathway.

Of the FES pathways, the Counterfactual pathway aligned most closely with the BaU scenario philosophy, representing the most pessimistic option in terms of decarbonisation. It is characterised by the slowest credible decarbonisation and renewable energy deployment, with minimal changes in consumer behaviour. Therefore, it best represents a scenario where the scope 2 emissions trajectory forecast for the Solent region does not account for any additional decarbonisation initiatives identified and implemented as part of this work.

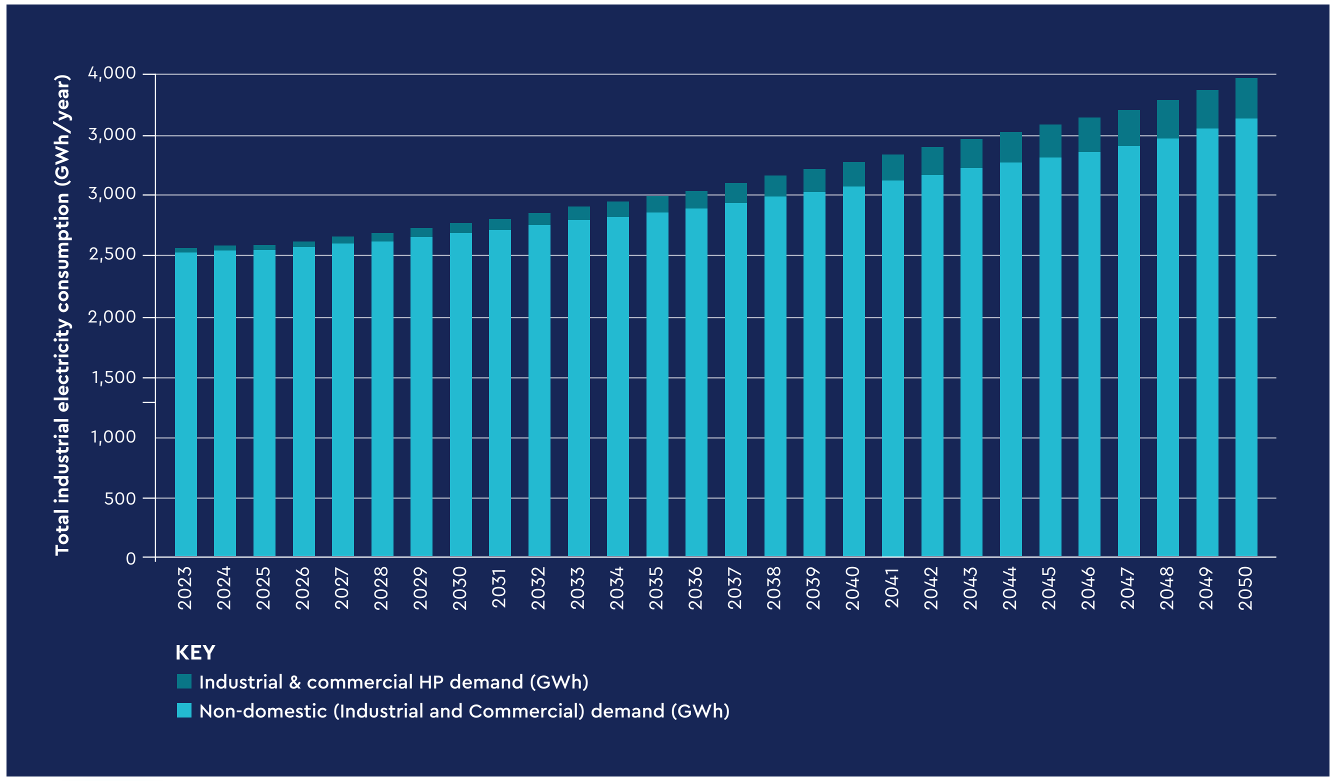
Scope 2 emissions were calculated using a location-based approach, where the emissions value is derived from multiplying the grid intensity factor by the electricity consumption. Emission factors at country level are relevant for the UK, as the power networks are all connected. As shown in Figure 18, under the Counterfactual pathway, the grid intensity factor shows a general decline, reaching a low of 21 $kgCO_2$/MWh by 2050. Although the most conservative of the FES pathways, this is ambitious and indicates a large replacement of fossil-fuel power generation with low-carbon alternatives, including renewables and nuclear, as well as some bio-energy carbon capture and storage (BECCS) in the power generation sector.

FIGURE 18: Grid emission factor under the National Grid FES Counterfactual Pathway



Electricity consumption is also forecast under the FES Counterfactual pathway, and is used as the projection for the BaU forecast. In the Solent region, both non-domestic and I&C heat pump demand categories show an increasing trend to 2050, explained by the anticipated rise in process electrification (cf. heat pumps trend) together with the economic growth of industrial entities in the region, as shown in Figure 19.

FIGURE 19: Projected total electricity consumption for industry in the Solent region, split by industrial and commercial demand, and heat pump demand, under the Counterfactual FES Pathway



59 *"2024 Future Energy Scenarios report"*, National Grid
60 *"2023 Future Energy Scenarios data workbook"*, National Grid

APPENDIX B

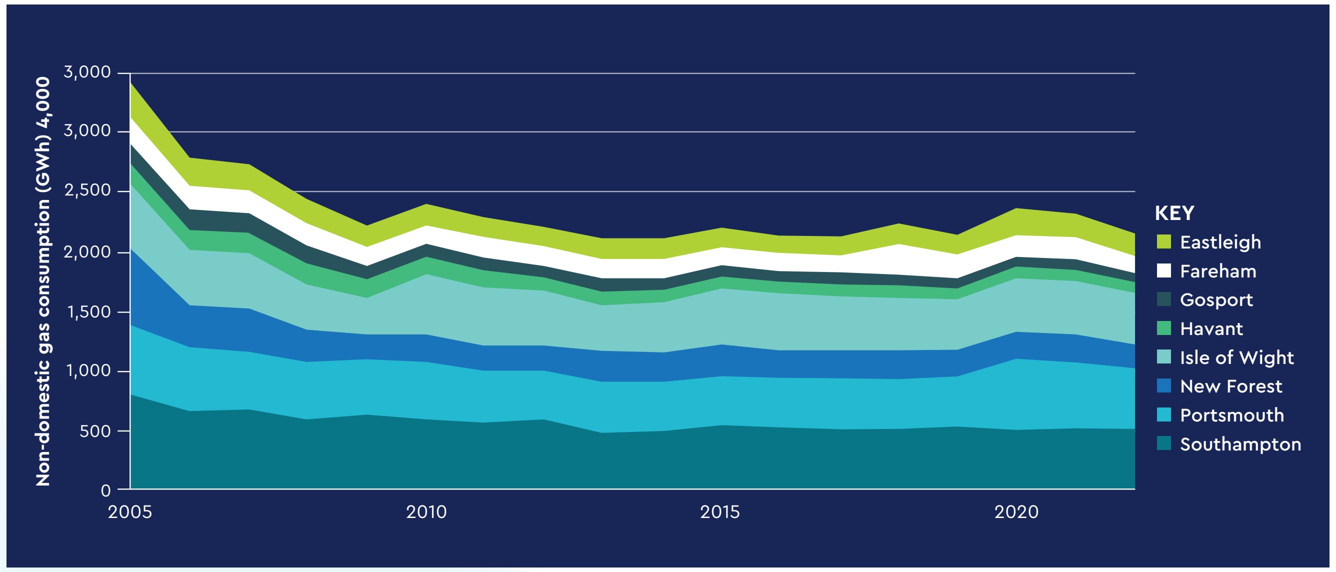
ESTIMATION OF ADDITIONAL NATURAL GAS EMISSIONS

As discussed in Appendix A, the approach used to establish baseline scope 1 emissions in this work focuses upon data from the UK Emissions Trading Scheme registry (UK ETS) and National Atmospheric Emissions Inventory (NAEI).

These datasets capture emissions data from point sources. As typically only larger facilities trigger emissions reporting thresholds, the emissions baseline data is likely to omit scope 1 emissions from smaller facilities across the Solent region. The estimate of 5.3 $MtCO_2e$ in scope 1 emissions in 2023 for industry in the Solent region is therefore likely to be an underestimate.

An additional estimate was made of industrial gas demand within the Solent area, given that a major source of any scope 1 emissions from smaller facilities is likely to be through natural gas consumption. These additional industrial natural gas emissions are estimated at up to 1.6 $MtCO_2e$ in 2023.

FIGURE 20: Historical gas consumption across non-domestic sites in the Solent region, split by sub-region (2005–2022)
This suggests that 2022 is likely to be representative of typical natural gas consumption in the Solent region.



METHODOLOGY

This was analysed by collating postcode gas consumption statistics from SGN, using the same defined geographical boundary as the approach described in Appendix A to estimate scope 2 emissions.[61]

As this SGN dataset for demand by postcode is only available for financial year 2022/23, a check was also made of historical non-domestic gas consumption in the local authorities within the Solent region.[62] As shown in Figure 20, there is no clear changing trend in these values,

61 *"Open data sharing portal"*, SGN
62 *"Regional and local authority gas consumption statistics"*, HM Government

suggesting that consumption for financial year 2022/23 can be considered as representative of typical demand.

However, there is some uncertainty in this estimation of this additional natural gas consumption. In areas where there is a high concentration of industrial sites, such as the SO45 postcode, including Hythe and Fawley, it is difficult to estimate the level of double counting of gas emissions between point source emitters already included in the NAEI and UK ETS datasets, and from smaller industrial sites. It is assumed that major facilities such as refineries and energy recovery facilities would consume limited natural gas via the gas network.

ACRONYMS AND DEFINITIONS

TERM	DEFINITION
BaU	Business as usual
BECCS	Bioenergy with carbon capture and storage
Blue hydrogen	A method of low carbon hydrogen production, where natural gas is reformed into hydrogen and carbon dioxide, with the carbon dioxide captured and stored using carbon capture and storage (CCS).
BMS	Building Management System
BSP	Bulk Supply Point
CCC	The Climate Change Committee
CCS	Carbon capture and storage
CO_2e	Carbon dioxide equivalent. *This is a measure used to compare relative impacts of various greenhouse gases. Impacts of non-CO_2 greenhouse gases can be shown in terms of the equivalent amount of carbon dioxide with the same global warming potential.*
DAC	Direct air capture
DESNZ	Department for Energy Security and Net Zero
ERF	Energy recovery facility
Pre-FEED study	Preliminary Front-End Engineering and Design study. *This is a conceptual design stage for an engineering project. These take place after a feasibility study and before a Front End Engineering Design (FEED) study.*
GHG	Greenhouse gas
Green hydrogen	A method of low carbon hydrogen production, that utilises electrolysis to separate water into hydrogen and oxygen. Renewable electricity is used to power the process.
GSP	Grid Supply Point
GVA	Gross Value Added
GW	Gigawatt
GWh	Gigawatt hour
$ktCO_2e$	Thousand tonnes of carbon dioxide equivalent. *See CO_2e for description of carbon dioxide equivalent.*
I&C	Industrial & commercial
LED	Light emitting diode
LIDP	Local Industrial Decarbonisation Plan

TERM	DEFINITION
Methanol	A chemical that can be used for a range of industrial uses and as a fuel, including in maritime. Traditional methanol production uses fossil feedstocks, but renewable methanol can be produced using biogenic CO_2 and low carbon hydrogen, and represents a potential low carbon fuel.
MRO	Maintenance, repair and overhaul
$MtCO_2e$	Million tonnes of carbon dioxide equivalent. *See CO_2e for description of carbon dioxide equivalent.*
MW	Megawatt
MWh	Megawatt hour
NAEI	National Atmospheric Emissions Inventory
National Grid FES	National Grid Future Energy Scenarios
Offtaker	A party buying a product or service from a project. In this context, this may refer to an organisation purchasing hydrogen or utilising carbon transport and storage infrastructure.
R&D	Research and development
SAF	Sustainable aviation fuel
Scope 1 emissions	Direct emissions from sources that organisations directly own or control, such as fuel combustion. This does not include emissions associated with electricity production, that is then purchased and consumed by an organisation.
Scope 2 emissions	Indirect emissions associated with the purchase and consumption of energy, such as electricity.
Solar PV	Solar photovoltaic
Solent LSIP	Solent Local Skills Improvement Plan
tCO_2e	Tonnes of carbon dioxide equivalent. *See CO_2e for description of carbon dioxide equivalent.*
Track 1 and 2 clusters	Industrial clusters with CCS that have been prioritised for initial funding, under the UK Government's cluster sequencing. Two clusters – HyNET and East Coast Cluster – were selected as Track 1 in 2021. In 2022, the Acorn project in Scotland and Viking project in the east of England were announced as the selected Track 2 clusters.
UK ETS	UK Emissions Trading Scheme
VSD	Variable Speed Drive

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