Shoreham Port Industrial Cluster

Local Industrial Decarbonisation Plan

Funded by UK Government

Innovate UK

Shoreham Port Industrial Cluster

Foreword

This 'Local Industrial Decarbonisation Plan' developed by the Shoreham Port Industrial Cluster is the result of a year long collaborative process of wide-ranging research, in-depth analysis, scenario modelling and consultation. Funded by Department for Energy Security and Net Zero, delivered by Innovate UK– UKRI, this collaboration has brought together core partners of Shoreham Port Authority, Adur & Worthing Councils, Brighton & Hove City Council, Barrett Steel Limited, Cemex UK, Local Fuels Limited, Ricardo UK and University of Sussex alongside local businesses and members of the community. Our plan demonstrates how the Shoreham Port Industrial Cluster can build on the long history and strengths of a Trust Port as it evolves into a zero-carbon centre for trade, employment, and inclusive community engagement.

One of the core strengths identified through the research is the diversity of the activities underway across the Port; cargo, fishing and leisure marine users are complimented by the vast array of large and small businesses based in the location. Renewable energy generation, the gas fired power station, water treatment plant and proximity to the offshore wind farm bring essential utilities to the Industrial Cluster.

The Plan's commitment to creating good quality local employment is vital to the region. The research has identified that over 1600 people work directly within the Cluster, underlining the integral role the Port ecosystem plays in the regional economy. The Plan recognises the opportunity to create additional job opportunities as the transition to a zero-carbon future is undertaken, these new energy systems will require different ways of working and skill sets. The Cluster benefits from strong relationships with local schools through to regional universities, many of whom have been directly involved in this research. It is through these relationships that the Cluster will be a catalyst for addressing future skills requirements, enabling a local workforce ready for growth. With the strong values-based leadership demonstrated through the collaboration, we are confident the transition can be part of creating a more inclusive and equal future for everyone.

Our region has unparalleled natural assets, coupled with extensive Port facilities, renewable power generation, investment-ready land serviced by extensive supply chains and the ambition to play a leading role in the country's net zero journey. Through working together – Industry, Government, Academia and Communities - we will build a Shoreham Port Industrial Cluster which enables decarbonisation alongside economic growth, creating sustainable local employment and attracting inward investment.

Tom Willis
Chief Executive,
Shoreham Port

Bella Sankey
Leader, Brighton
& Hove City
Council

Jeremy Gardner
Leader, Adur
Council

Professor Sasha Roseneil
Vice-Chancellor &
President,
University of
Sussex

1 Contents

2 Executive Summary

This Local Industrial Decarbonisation Plan (LIDP) sets out the process, options and scenarios for decarbonising the Shoreham Port Industrial Cluster (SPIC). Developed during 2024 this project was formed through a collaboration initially consisting of Shoreham Port Authority, Adur & Worthing Councils, Brighton & Hove City Council, Barrett Steel Limited, Cemex UK, Local Fuels Limited, Ricardo UK and University of Sussex.

For the first time, the research undertaken through this project has established data on the scale of employment, energy usage and carbon emissions across the Cluster. This data was then used to model decarbonisation pathways through the lenses of several scenarios. Throughout the project learning has been captured for the purposes of knowledge dissemination across the national network of industrial clusters, maritime sector and beyond.

Throughout, the project has been guided by the 'Cluster Framework' provided by UK Research and Innovation (UKRI), modelling how cluster and national decarbonisation may be achieved via four key components, as shown in Figure 1.

The research has highlighted the vast range and diversity of activity currently taking place across the Shoreham Port Industrial Cluster, the data collection has identified that in 2023 the Cluster directly supports over 1600 local jobs and thousands more across supply chains. The Cluster is well positioned to be a catalyst for further economic growth, creating new employment opportunities as the energy transition is undertaken.

The analysis establishes a 2023 emissions baseline of nearly 17,000 tonnes of CO_2 emitted by on site activity and advocates for a decarbonisation pathway replacing diesel, which has historically been the Cluster's primary energy source, with electricity. Significant expansion of renewable energy generation will be required to meet a forecast electricity demand within the cluster of 25.5GWh by 2035. The study has also highlighted that the Cluster continues to present many attractive conditions for hydrogen production with marine transport and local hinterland demand the primary potential sources of offtake.

Much of this project's success can be attributed to collaboration. The time, enthusiasm and expertise offered by individuals and organisations has enabled the complex pathway to decarbonisation to be understood and mapped. The sharing of data, insights and opinions has ensured the plan is grounded in reality, with the potential to make a lasting difference to the businesses and communities based in and around the Cluster. Future deployment needs to maintain the 'cluster mindset' which will be essential to the implementation of the plan and ongoing decarbonisation. Please do not hesitate to contact the Shoreham Port Industrial Cluster team via sustainability@shoreham-port.co.uk to get involved.

Figure 1 Cluster Framework (UK Research and Innovation [UKRI], 2023)



Introduction

3 Introduction

3.1 The need for Net Zero

The impacts of climate change are increasingly clear to see, from sea level rise to extreme weather events, the need to decarbonise and protect the future of our planet is more urgent than ever (United Nations, n/d). 'Disrupting national economies and affecting lives and livelihoods', research has shown that without action, the overall costs and risks of climate change will resemble an equivalent loss of between 5-20% of global GDP each year, threatening social and economic security and affecting every ecosystem on the planet (HM Treasury, 2006).

Whilst many greenhouse gases occur naturally, human activity contributes substantially to their accumulation, rendering anthropogenic emissions of CO_2 and other greenhouse gases a primary cause of climate change, as they become trapped in the atmosphere, warming the planet (European Parliament, 2023) and contributing to "one of the world's most pressing challenges" (Ritchie & Roser, 2020).

A global problem, requiring a global response, the UK became the first major economy to commit to a legally binding target to reach net zero greenhouse gas emissions, setting 2050 as the deadline and outlining a series of ambitious pledges by which to achieve this. With countries around the world following suit, acting to limit global warming to 1.5°C, as in line with the Paris agreement, commitments and targets are now being set internationally, requiring significant reforms in policy, innovation and technology. The new IPCC assessment report makes clear that profound societal change along with continued technical improvements will be required to meet our climate goals, as well as to improve people's quality of life and ensure thriving economies and ecosystems (The Intergovernmental Panel on Climate Change [IPCC], 2019).

With approximately 14% of the UK's emissions stemming from industry and over half of these emissions coming from industrial clusters, (sites upon which industrial businesses are concentrated) to meet the UK's net zero goal, significant action is needed (UKRI, 2023).

This challenge has been recognised by the UK Government, who via investment in UK Research and Innovation (UKRI) are seeking to address the substantial societal and economic challenges facing UK businesses, specifically targeting the decarbonisation of industry.

Launched in 2019, the Industrial Decarbonisation Challenge (IDC) sought to support the development of low-carbon technologies and infrastructure, increasing industry competitiveness and enhancing its contribution to the UK's clean growth. Targeting energy intensive industries, such as iron, steel and cement, the five-year project sought to support six distinct industrial regions of the UK in understanding their emissions and producing a plan to decarbonise, with the ambition of creating low-carbon clusters by 2030 and the world's first zero carbon cluster by 2040.

Seeking now to target dispersed industrial locations beyond the UK's existing industrial clusters, the Local Industrial Decarbonisation Plans (LIDP) competition, run in partnership with Innovate UK (IUK) part of UKRI, provided a share of £6 million of funding to support the development of place-based decarbonisation plans, demonstrating collaboration between closely located industrial businesses.

Bringing together Shoreham Port Authority, Barrett Steel Limited, Local Fuels Limited, Cemex UK, Brighton & Hove City Council, Adur & Worthing Councils, Ricardo Plc and University of Sussex the Shoreham Port Industrial Cluster was formed. In December 2023 the cluster was successful in securing a portion of the funding available through the LIDP competition (Department for Energy Security and Net Zero [DESNZ], 2023), which has enabled this research and report.

3.2 A Hub for Trade & Employment

The last 260 years have seen Shoreham Port diversify to become a hub for over 200 businesses. With nearly 2 million tonnes of cargo passing through the Port each year, the Port has developed into an established industrial cluster, feeding into the regional and wider economy and providing skilled jobs spanning a range of sectors. As the Port's estate and activity has evolved, so too has demand for essential utilities such as energy, water and transportation. Though shipping continues to be one of the most environmentally benign modes of transportation regarding goods transported per mile, the movement of goods between countries and into market requires numerous industrial processes (Pike et al, 2011; Xiao et al, 2025). Constituting the bulk of activity and energy demand across the estate, industrial activity arising from the use of plant equipment, haulage and vessels discharging cargo, must be decarbonised.

3.3 Developing our Plan Collaboratively

With around 40% of industrial emissions attributable to dispersed sites, defined as "industrial sites located outside of industrial clusters" (UK Research and Innovation, 2023, p5; Climate Change Committee, 2023), collaboration is essential in understanding the social, economic and environmental impacts of our Cluster and developing a viable plan by which to decarbonise. A hub for businesses ranging from SMEs to major multinational organisations, collaborative research has been key in understanding the collective impact of the Cluster, communicating with over 200 individual organisations and Port users to map our collective social, economic and environmental impact, providing insights at an unprecedented scale. As outlined in sections five and six, we have sought to capture the diversity of requirements and ambitions organisations hold within the Cluster, facilitating knowledge sharing to accelerate the identification of barriers and enablers of industrial cluster decarbonisation. Collectively, this has enabled the development of a thoroughly informed plan.

With no one size fits all approach for decarbonisation at scale, navigating this landscape is complex, requiring collaboration not only in the creation of a decarbonisation strategy itself, but in the deployment of future technologies, with the adoption of common infrastructure, further policy guidance and connectivity key in avoiding the risk of stranded assets with limited uptake. Working with our stakeholders to pursue a shared green future, this plan will remain a living document, respective of an ever changing social, economic and political landscape.

3.4 Cluster Governance

Figure 2 Project Partners

The Shoreham Port Industrial Cluster (SPIC) has brought together Shoreham Port Authority, Adur & Worthing Councils, Brighton & Hove City Council, Barrett Steel Limited, Cemex UK, Local Fuels Limited, Ricardo UK and University of Sussex to collaborate on a year-long programme of research, detailed analysis, and consultation. The programme engages stakeholders across the cluster to determine and evaluate viable routes to decarbonisation. Building on previous investments which include, alternative fuels, low emission vehicles, and on-site renewable energy production, the plan aims to map out the vital steps to achieve decarbonisation. Drawing upon the expertise of project partners, providing user-perspectives, specialist consultancy advice and input representative of the locality and industry, the partnership has sought to identify viable solutions respective of cost, infrastructure and potential constraints such as grid connectivity and user-needs, informing this plan and associated academic reports. The insight and expertise this collaboration has unlocked has been absolutely fundamental in guiding our approach to the project.

3.5 Collaboration Beyond the Cluster

One of thirteen Local Industrial Clusters supported by the programme, collaboration with other clusters, including those currently under the programme, established clusters from the first Industrial Decarbonisation Challenge and self-established local hubs, has been invaluable throughout the course of the project. Though the context within which any industrial business or cluster seeking to decarbonise may vary, many of the challenges faced in understanding collective industrial impact at scale are shared. Navigating a landscape of new, alternative green technologies under which deployment at scale poses immense risk, the ability to discuss impacts, risks and mitigation, sharing successes and barriers has shaped the creation of this plan and will continue to guide the proposals outlined into deployment and beyond.

Collaborating not only with established clusters, throughout the course of the project we have engaged with organisations seeking to understand the likely outcomes of the project, understanding the barriers faced, formats followed and crucially the opportunities it can unlock.

With the publication of this plan, we hope to continue these discussions, collaborating with organisations seeking to pursue a greener future both in the Shoreham Port Industrial Cluster and beyond.

Shoreham Port

4 Shoreham Port

Spanning 110 acres, the Shoreham Port estate contains over 200 businesses, comprised of industrial quayside, associated plant and large-scale warehouses, through to smaller units and modern serviced offices, all concentrated around the locked canal and harbour, through which all maritime cargo transits. A crucial hub for trade and employment, supporting over 1600 direct jobs on land and water, this section provides an overview of the Port and wider Cluster, it's social and economic impact and the need to decarbonise.

4.1 Our Trust Port Status

Established by an Act of Parliament in 1760, Shoreham Port is a key, longstanding feature of the Sussex coastline. As a trust, Shoreham Port has a commitment to develop as an economic and cultural asset for the region, through custodianship and continual improvement, remaining publicly accountable to its multiple stakeholders. Reinvesting profits generated to benefit the surrounding communities and economies it serves, sustainable decision making underpins the Port's long-term future, ensuring it remains a successful organisation for years to come, serving the local community, Sussex region and international markets.

Shoreham Port is a values driven organisation (see graphic below), focussed on being 'trusted custodians' of the communities, estate and history it sustains. Holding Eco-Port status for over a decade, Shoreham Port continually strives to ensure things are left better than they are found, doing everything possible to reduce impacts across land, sea and air, engaging with stakeholders to collectively pursue a greener and fairer future.

4.2 Cargo

Since its inception, the Port has been a major economic driver for Sussex and the southeast region, primely situated at the mouth of the river Adur on the English Channel, and adjacent to key national transport links for the onwards transportation of cargo.

Facilitating the movement of goods to and from ships and into local communities and international markets. Each year, around 2 million tonnes of cargo pass through the Port, including timber, steel, aggregates, bulks and glass, as well as petroleum, woodchip and cereals. Managing cargoes from countries including Sweden and Latvia, Northern Spain and mainland Europe, as well as those closer to home, such as Scotland, Ireland and Wales, the Port provides discharge services, storage, and onwards transportation for a range of cargoes and specialist projects.

4.3 Fishing & Marine Leisure

The third largest fishing port in England by catch value, with approximately 15 million pounds worth of fish landed each year, seafood constitutes a further key commodity for the Port, offering visiting and local vessels sheltered moorings within the locked canal (Marine Management Organisation, 2024). The Port is home to a variety of small boat fishers, including netters and potters, as well as visiting trawlers, targeting a variety of species, predominantly scallops, sole, plaice, cuttlefish and whelks.

With several fish wholesalers located within the Cluster, alongside plant equipment and HGV services, the Port's location and facilities are perfectly positioned to enable the transition from catch to plate, facilitating the quick delivery of goods and supporting over 230 direct jobs within the fishing industry.

Seeking to further enhance the long-term sustainability and viability of this crucial industry, Shoreham Port has secured several rounds of investment from the UK Seafood Infrastructure Fund, a competitive process administered by Department for Environment, Food and Rural Affairs (DEFRA) and the Marine Management Organisations (MMO).

This has enabled the reopening of a Dry Dock, providing an essential facility for fishers, enabling proactive and preventative maintenance activities to be undertaken within the cluster, minimising time out of the water and negating the need to travel further afield, hence reducing emissions.

Focused on visiting commercial fishing vessels, the Port's Berth Zero project is seeking to introduce shore-power via the installation of plug-in renewable electricity, with the intention of enhancing sustainability, efficiency, and crew welfare.

Opened in January 2025, Fishersgate Marina, the Port's inshore fishing marina has also been undergoing a drastic reconfiguration, set to double capacity for fishing vessels, modernising facilities and improving safe working methods.
In addition, the Port also offers high-quality moorings for leisure vessels, welcoming over 14,000 leisure boat movements through its lock gates annually, with numerous sailing clubs operating along the coast and out of the Harbour.

4.4 Property

Over the past decade, a strong diversification strategy has brought different businesses to the Port. Evolving to offer serviced office space and light industrial units through to larger-scale warehouse facilities and quayside, the Port has developed into a significant industrial cluster, whose ecosystem comprises over 200 businesses ranging from small and medium-sized enterprises (SMEs) to major multinational companies. Providing vital social and economic context in the development of this plan, a breakdown of businesses based within the cluster and jobs supported can be found in Figure 4.

4.5 Unique Opportunities within the Region

Located to the North of the English Channel, the Shoreham Port Industrial Cluster is strategically positioned to harness renewable energy, which sat alongside port facilities, investment-ready land and scalable opportunities sees the cluster poised to lead the way in a greener future for our region. Key opportunities are described below:

4.5.1 Renewable Energy

As a coastal location, wind constitutes a substantial natural asset, with Rampion, an extensive offshore windfarm, situated 13km south of the Port. Providing 400MW, enough electricity to power half the homes in Sussex, plans if approved in early 2025 will see Rampion expanding to supply electricity capable of powering a further million homes, over three times current generation levels, achieving significant decarbonisation for the region.

On shore the Port generates a yearly average of 400MWh in wind energy from two 100kW wind turbines located on site, feeding directly into pumps which operate the lock gates to the Port's entrance.

With over 11,000 solar panels in place across the Port, providing up to 2520kWp and directly powering onsite activity, solar PV represents a substantial and proven opportunity. Facilitating reduced dependence on the grid and vulnerability to external factors, these assets enable not only a reduction in emissions but also provide stability in increasingly volatile energy markets. This enhanced stability in price and availability of fuel provides in turn an incentive to invest in infrastructure to localise energy production.

4.5.2 Utilities

The Cluster is home to a 420MW Combined Gas Cycle Turbine plant operated by VPI and hosts a Southern Water wastewater treatment plant. The power station operates as a standby facility, generating energy only to meet demand, supplying 400,000 homes along the South Coast. Recycling wastewater from the local area, the Southern Water operated facility serves a population of over 60,000, cleaning and purifying wastewater before returning it into the sea.

4.5.3 Shipping

Facilitating over 500 cargo shipping movements a year on average, Shoreham's position as a commercial Port presents substantial opportunity. Currently providing small-scale bunkering for leisure and fishing craft, with shore power for commercial fishers due to be operational from early 2025 and larger-scale fuelling facilities on site capable of bunkering cargo vessels, there exists opportunity to evolve and expand facilities to facilitate the import, storage and bunkering of future fuels.

4.5.4 Proximity & Connectivity

Across the region, including within close proximity of the Port, there exist numerous industrial and large-scale businesses who possess significant energy and fuel requirements (West Sussex County Council, 2023). Longstanding relationships with many of these, in addition to those held with institutions, councils and researchers within the region position the Port as a driving force for innovation and a key centre for collaboration across the wider Sussex region.

The last decade in particular has seen the initiation of numerous collaborative projects across Sussex, seeking to drive change and pursue a greener future for the region. Focusing on the transition to sustainable, decarbonised energy systems, partnerships including Sussex Energy, Hydrogen Sussex and Greater South East Net Zero Hub have brought together researchers, industry and Local Authorities with the ambition of supporting and facilitating a low carbon future for the region. Sat alongside council plans, which include heat capture and energy networks there exists immense opportunity to collaborate in the pursuit of a low carbon future, combining resource and knowledge across the region (Brighton & Hove City Council, 2024).

Acknowledging the immense value in the region's natural capital, providing crucial ecosystem services underpinning the stability of our economy and society, there also exists numerous partnerships for the protection, regeneration and long-term sustainability of biodiversity across the region, with the Cluster itself located within a designated UNESCO Biosphere. Targeting both broader ecosystem services, down to the protection and restoration of specific species, the region plays host to an abundance of organisations and projects, collaborating to share knowledge and drive change.

4.6 Building on a Portfolio of Existing Projects

Trust Port ambitions and values, combined with the need to align with policy and decarbonisation targets transcending from global to regional and sectoral level has seen sustainability evolving into a guiding principle for organisational decisions. Presenting a crucial opportunity to take a cluster wide view of the estate, this project builds upon a portfolio of existing research, projects and developments which have taken place. Below, several key developments are shared:

4.6.1 Shore Power

Supported through a grant from the DEFRA, in collaboration with the MMO 'Berth Zero', a project ongoing at the time of this research, will see the installation of shore-power supply, enabling visiting vessels to run on electricity whilst at berth. Focussed on the Port's nomadic fishing fleet, with the intention of enhancing sustainability, efficiency, and welfare, the installation of plug-in shore-power, powered by renewable energy generation will enable visiting vessels to switch their auxiliary engines off whilst berthed within the Port. Plugging into shore power as a means of power supply and hence avoiding the use of fossil fuels and associated emissions, the project is forecast to reduce approximately 900 tonnes of CO_2 emissions annually. Facilitating benefits not only in air quality, the installation aims to enhance crew comfort and reduce noise levels, ultimately attracting more commercial fishing visits and boosting economic activity in the region.

Also seeking to implement shore power within the cluster, project partners Cemex UK are in the process of developing a shore power system for their aggregate vessel, the Cemex Go Innovation. With aggregates a key cargo for the Port, supporting construction and civil engineering across the region, the project will enable the vessel to use renewable fed battery storage whilst alongside, utilising an advanced system, capable of recognising the self-discharging vessel's electrical load fluctuations. An innovative project, it forms part of the Clean Maritime Decarbonisation Competition Round 4 (CMDC4) funded by the UK Department for Transport (DfT) and delivered by Innovate UK.

4.6.2 Transition from Fossil Fuels

Recognising the urgency with which action must be taken to reduce emissions and the significant development still required before fossil fuels can be entirely swapped out for green fuel sources at industry level, a recent transition to ISCC certified Hydrogenated Vegetable Oil (HVO) has facilitated a substantial reduction in emissions. Used in Port operated Non-Road-Mobile-Machinery and marine vessels, the exchange facilities an 80-90% reduction in emissions compared to fossil fuels, representing a stepping stone on the journey towards a greener future, whilst acknowledging HVO as an interim solution. Seeking to enhance accessibility to this drop-in alternative, whilst simultaneously benefitting fuel security for the cluster and region through the creation of a supply chain, collaboration within the cluster has sought to create a HVO supply chain, enabling supply of the low carbon fuel across the region. Newhaven Port have recently benefitted from transitioning to HVO with further partners set to join.

4.6.3 Electrification

A cluster spanning 110 acres, Port operated vehicles provide a crucial means of transiting the estate. With the majority of these journeys multiple yet short in distance, the duty cycles have readily facilitated the transition to Electric Vehicles.

With several port-owned vessels also conducting shorter passages, electric technology presents a further opportunity on water. Acknowledging this, Shoreham Port is working with Ecomar Propulsion to trial an electric workboat within the Port's canal. The project has proved valuable in facilitating a means of navigating the Port's waterway without the requirement for fossil fuels. Where shorter routine journeys may be conducted, electric vessel technology presents a notable opportunity.

4.6.4 Decarbonisation of Heat

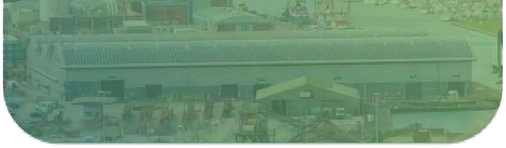
With over 200 businesses located across the estate, there exists notable demand for utilities including water, electricity and heat. Installing a Marine Source Heat Pump to replace traditional oil-fired heating and hot water systems, the implementation of this technology has seen a reduction in around 70 tonnes of CO_2 annually, decarbonising thirty serviced office units.

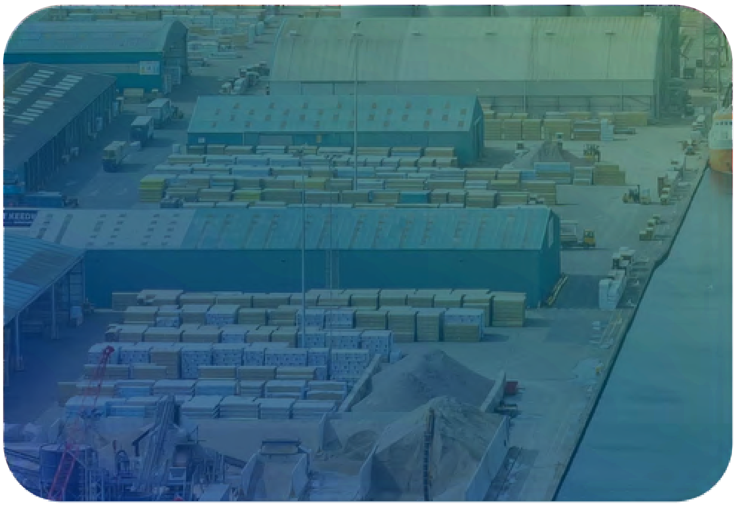
4.6.5 Hydrogen Production

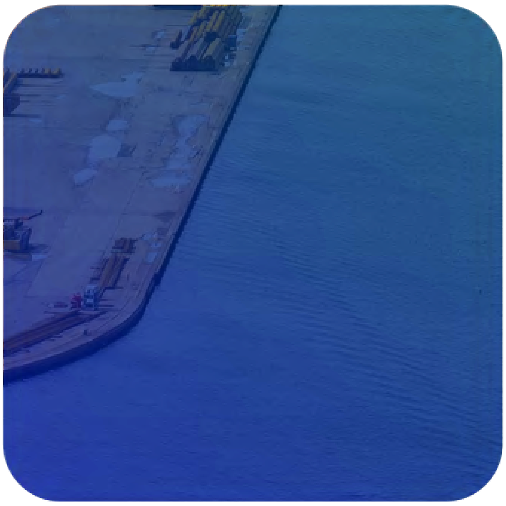
Over the past five years, commercial partnerships have been formed to jointly explore the feasibility of hydrogen production facilities within the Cluster. The availability of operational land, renewable energy and multiple potential off takers give the location several inherent advantages. At this stage none of the previous partnerships have reached full investment decisions, in part linked to the initial surge in national hydrogen demand forecasts tempering. With section seven highlighting the emissions impact the fuel can facilitate, there remains an opportunity to continue to explore hydrogen production within the cluster, focussed on the multiple potential off takers, both within the Cluster and the wider hinterland.

4.6.6 Proactive Research

Alongside these larger infrastructure projects, numerous research studies in partnership with Royal Haskoning and Ricardo PLC, cluster partner, have taken place with a view to better understanding the impact on surrounding air quality and potential mitigation strategies. Two energy utilisation studies have been undertaken by Ricardo PLC, providing crucial insight on the challenges and opportunities the cluster faces in pursuing a greener future.








Methodology

5 Methodology

5.1 Approach to Data Gathering

In order to produce a viable and credible plan for decarbonising the SPIC, an accurate baseline is essential, profiling key social, economic and environmental data, to produce an emissions baseline inventory and profile of activity taking place within the cluster. Though direct Port operations and commercial activity constitute a proportion of total emissions and activity, with over 20 industrial tenants located on site, 180+ SMEs and over 500 commercial shipping movements a year, energy demand and emissions are dispersed across the cluster, making data collection from multiple stakeholders essential.

So as to ensure all relevant data, attributable to the Industrial Cluster was captured, a cluster boundary was drawn, using the logical physical boundaries of the sea to the South and the A259 to the North. Recognising that sound and emissions impact communities far beyond this boundary, there were no restrictions placed on engagement, with everyone welcome to contribute, regardless of geographical location.

Figure 3 Cluster Boundary

To maximise efficiencies, a review of data inventories and previous studies conducted within the Cluster was completed, including work previously undertaken by Ricardo PLC and Shoreham Port Authorities own profiling of energy consumption and terrestrial and marine activity. The review helped to create a baseline of existing knowledge as a foundation for the project to build upon. For other stakeholders and on-site activity on which data was not yet held, the data collection process took the form of a survey, distributed to all tenants and businesses based across the Cluster. Targeting industrial businesses and SMEs separately, two discreet surveys were created and distributed across a four-month period, tailoring the data gathering process on industrial businesses to focus on operational demand and supply, including data on Heavy Goods Vehicles (HGVs) and Non-Road Mobile Machinery (NRMM).

In order to increase the likelihood of getting a strong response rate from stakeholders, it was important to balance the number of questions and the level of detail, to ensure sufficient information valuable to the study. Where stakeholders did not respond or gaps in data existed, a combination of validation methods were used, profiling businesses relative to scale, social and economic impact and dividing the data sets into four categories to aid validation. These four categories were then adopted for the remainder of the study, owing to the distinctions they enable and will be used as such in the rest of the report. The four categories include:

Port energy consumption: Buildings, NRMM, vessels, vehicles and HGVs operated by Shoreham Port Authority.

Industry energy consumption: Industrial activities, buildings and NRMM used by industrial businesses in the cluster.

Non-industry: other businesses in the cluster that do not classify into industry, such as light commercial and offices.

Third party vessels: vessels that are not Port operated. In this case, we consider only their auxiliary engine use while at berth. Vessels that we considered in the study included fishing and cargo vessels using data provided by Shoreham Port Authority.

In parallel to this research, interviews were also conducted with key stakeholders from both the cluster and the wider field of industrial decarbonisation, exploring themes including policy, governance, business strategy and the challenges and opportunities facing industrial businesses on the path to decarbonisation. The knowledge gained from these interviews is summarised in three thought leadership papers published in parallel to this report, featuring in three academic journals. Details on these can be found in the Annex of this report, with the research conducted providing vital context throughout this report.

5.2 Data Analysis

Undertaking extensive data analysis, corresponding inventories were compiled analysing the social, economic and environmental impact of the cluster, with each category providing key context on each other and facilitating the development of a set of baseline assumptions. From these an energy demand forecast and defined generation and demand options were developed, forecasting up until 2035 under a series of scenarios for the Cluster, taking into account extensive data sets concerning projected cargo growth. These scenarios considered distinct fuels and generation options for electricity. For each of these potential generation options, a set of reasonable technical and financial assumptions were developed for the energy modelling. Following development of the forecasts, energy modelling for the scenarios was undertaken. The main output of this step was to create a timeline for projects under each selected scenario.

5.3 Scenario Modelling

The road to net zero is complex and the landscape within which decarbonisation must take place remains incredibly fluid as the policies, regulations, innovations and technologies seeking to enact it evolve at varied pace. Forecasting a decarbonisation strategy with such uncertainty requires a holistic approach and a methodology capable of cutting through this, identifying an optimal strategy. Creating a single decarbonisation "solution" is unlikely to reflect a future reality and does not allow comparisons. Therefore, to analyse the potential pathways available for the Cluster and help identify an appropriate way forward three plausible decarbonisation scenarios have been developed, which may be compared with one another and against a ‘do nothing' approach by which we can assess our impact. It remains highly likely the eventual route followed is likely to reflect successful elements from across the different scenarios.

The 'Do nothing' scenario assumes the Cluster does not make any additional progress towards decarbonisation besides activity currently underway to implement shore power and reverts to the use of diesel as the predominant fuel for its equipment and marine vessels, instead of HVO, as used since 2023. The other three scenarios developed are listed below:

HVO uptake: Expanding HVO as the predominant fuel across the Cluster, following the path and progress initiated by Shoreham Port Authority, with additional uptake of renewable energy and energy management across the estate. For the rest of this report, the scenario will be referred to as the 'HVO uptake' scenario.

Electrification: Shift to electrify equipment within the Cluster, increasing shore power, and additional uptake of renewable energy and energy management across the estate.

Alternative fuels: Uptake of alternative fuels, mainly methanol and hydrogen, and additional uptake of renewable energy and energy management across the estate.

To model these scenarios, input assumptions were developed regarding the type and quantity of equipment converted to run on different fuels and timelines. So as to create a well-informed plan, this has been modelled against economic data including the economic ambitions of our tenants and Shoreham Port Authority's own goals for growth in cargo handling, as well as accounting for the fuel switch that has already occurred in the Port's NRMM and vessels (i.e. the Port has switched the NRMM and vessels to run on HVO since 2023). The three scenarios listed above are based on the assumptions provided in the tables below for 2030 and 2035, which were treated as the milestone years. However, though three distinct scenarios have been presented, in reality the choice and path followed will depend on cost and availability, and some precise detail may vary. For example, hybridisation may constitute a practical bridge technology and hydrogen may supplant methanol for smaller, local vessels.

A key assumption worth noting was that marine gas oil continues to be the predominant fuel used in vessels while at berth in 2035 (80% of vessels use marine gas oil). This conservative assumption has been made on the basis that any switch in fuel type for commercial vessel operators requires the alignment and progression of numerous factors, including further technological development, policy and business decisions, by both vessel and Port operators. In addition to this, the modelling assumes the adoption of smart energy management, whereby the Cluster actively manages its energy consumption, allowing power transfer during peak demand periods, in addition to the sharing of electricity generated from on-site renewables across the Cluster by 2030.

Table 1 Input assumptions for the 'HVO uptake' scenario

Scenario	Equipment	Port		Industry		Non-industrial tenants & non-tenants		Third Party Vessels – Auxiliary Engine	
		2030	2035	2030	2035	2030	2035	2030	2035
HVO Uptake	NRMM	100% HVO	100% HVO	100% HVO	100% HVO	-	-	-	-
	HGV	50% HVO 50% Diesel	100% HVO	20% HVO 80% Diesel	50% HVO 50% Diesel	-	-	-	-
	Energy efficiency	LED switch Replace gas boilers	-	Replace gas boilers	-	Replace gas boilers	-	-	-
	Light Vehicles	100% EVs	100% EVs	50% EV 50% Diesel	100% EVs	50% EV 50% Diesel	100% EVs	-	-
	Vessels	100% HVO	100% HVO	-	-	-	-	Shore Power: CEMEX and Berth Zero Remaining vessels: 100% marine gas	Shore Power: CEMEX and Berth Zero Remaining vessels: 80% marine gas oil& 20% HVO

Table 2 Input assumptions for the 'electrification' scenario

Scenario	Equipment	Port		Industry		Non-industrial tenants & non-tenants		Third Party Vessels – Auxiliary Engine	
		2030	2035	2030	2035	2030	2035	2030	2035
Electrification	NRMM	25% of fuel is replaced by electricity 75% HVO	50% of fuel is replaced by electricity 50% HVO	20% of fuel is replaced by electricity 80% HVO	50% of fuel is replaced by electricity 50% HVO	-	-	-	-
	HGV	50% HVO 25% of fuel is replaced by electricity 25% Diesel	50% HVO 50% of fuel is replaced by electricity	20% HVO 20% of fuel is replaced by electricity 60% Diesel	50% HVO 50% of fuel is replaced by electricity	-	-	-	-
	Energy efficiency	LED switch Replace gas boilers	-	Replace gas boilers	-	Replace gas boilers	-	-	-
	Light Vehicles	100% EVs	100% EVs	50% EV 50% Diesel	100% EVs	50% EV 50% Diesel	100% EVs	-	-

Scenario	Equipment	Port		Industry		Non-industrial tenants & non-tenants		Third Party Vessels – Auxiliary Engine	
	Vessels	100% HVO	1 Tugboat Electric and remainder on HVO	-	-	-	-	Shore Power: CEMEX and Berth Zero Remaining vessels: 100% marine gas oil	Shore Power: CEMEX and Berth Zero Remaining vessels: 80% marine gas oil & 20% Electric

Table 3 Input assumptions for the 'alternative fuels' scenario

Scenario	Equipment	Port		Industry		Non-industrial tenants & non-tenants		Third Party Vessels – Auxiliary Engine	
		2030	**2035**	**2030**	**2035**	**2030**	**2035**	**2030**	**2035**
Alternative Fuels	NRMM	25% Hydrogen with cranes as dual fuel 75% HVO	50% of fuel is replaced by hydrogen with cranes as dual fuel 50% HVO	20% of fuel is replaced by hydrogen 80% HVO	50% of fuel is replaced by hydrogen 50% HVO	-	-	-	-
	HGV	50% HVO 25% of fuel is replaced by hydrogen 25% Diesel	50% HVO 50% of fuel is replaced by hydrogen	20% HVO 20% of fuel is replaced by hydrogen 60% Diesel	50% HVO 50% of fuel is replaced by hydrogen	-	-	-	-
	Energy efficiency	LED switch Replace gas boilers	-	Replace gas boilers	-	Replace gas boilers	Replace gas boilers	-	-
	Light Vehicles	100% EVs	100% EVs	50% EV 50% Diesel	100% EVs	50% EV 50% Diesel	100% EVs	-	-
	Vessels	100% HVO	1 Tugboat and 1 Pilot cutter on methanol; the rest on HVO	-	-	-	-	Shore Power: CEMEX and Berth Zero Remaining vessels: 100% marine gas oil	Shore Power: CEMEX and Berth Zero Remaining vessels: 80% marine gas oil & 20% Methanol

5.4 Modelling Software - HOMER Pro

To model the electrification options of these scenarios, HOMER Pro (Hybrid Optimization of Multiple Electric Renewables) was utilised as the modelling software. Originally developed at the National Renewable Energy Laboratory (NREL), HOMER Pro is a powerful tool for optimising both off-grid and grid-connected microgrid designs. The software helps find the optimal combination of electricity supply projects and grid imports based on the energy system demand, costs and resource availability. HOMER finds the solution by simulating the energy system and finding the least cost combination of components that meet the electrical load of the energy system.

For running the simulation, the model requires inputs in the form of available technology options, renewable resource availability data and costs for each considered technology. HOMER then simulates thousands of different technology configurations and optimises for lifecycle costs. Each system configuration is simulated by making an energy balance calculation for each hour in a year and comparing load against supply.

5.5 Developing our Plan in Collaboration

A yearlong collaborative project, drawing upon vast quantities of data, research and extensive analysis, the outputs shared in the following sections have been guided by our stakeholders at every possible opportunity, designing a green future representative of the diversity of interests and requirements within our Cluster.

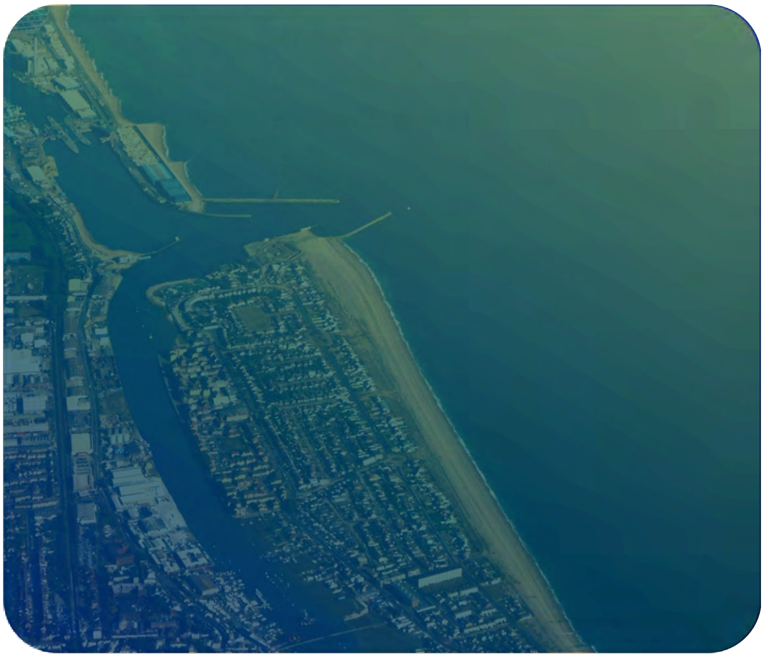
Drawing upon the input of over 20 industrial organisations and over 150 SMEs and involving our wider community through public facing events such as Shoreham Port's annual Sustainability Week, the project considers business needs and ambitions, side-by-side with the perspectives of our local and wider community. Undertaking a thorough project scoping, understanding the diversity of stakeholders and respective barriers and enablers different research types and topics may present, we have stood by our 'open doors' value and sought to design and manage an inclusive project, representative of the breadth of professions, opinions and requirements held by our stakeholders.

A project team comprising Shoreham Port Authority, two local councils, three key industrial organisations based within the Cluster, the University of Sussex and Ricardo PLC, this collaboration has drawn upon the expertise of all involved, facilitating vital knowledge exchange to inform the development of the plan from different key perspectives. Funded by DESNZ and delivered by Innovate UK, quarterly review meetings and the guidance of technical advisors provided the opportunity to assess progress and direction, remaining vigilant of risk and ensuring the plan remained informed and viable.

Collaborating with other Clusters and maritime organisations to understand the challenges we all face, discussing key learning points and enablers and sharing expertise, collaboration remains fundamental in the success of this project and to all future decarbonisation efforts.

Results



6 Results

6.1 A Green Hub for Business

With over 200 business located within the Cluster, designing and delivering a credible decarbonisation plan required the input of multiple stakeholders and the communities who live and work in the region.

Requesting the input of businesses based within the Cluster via surveys and workshops held throughout the year, we have been able to understand the composition of our Cluster, and the perceptions, concerns and aspirations our stakeholders have. This input has been vital in creating an informed and viable plan and we would like to thank all stakeholders who worked with us to share their thoughts and data.

6.2 Cluster Composition

Located just five miles from the city centre, the Port is not only well positioned for fishers and industrial organisations specialising in the transportation and dispersal of goods into market but as an economic hub, catering to a wide range of businesses across the Cluster. Having adopted a strong diversification strategy, understanding the sectors supported within the Cluster provides a vital foundation from which to assess the Clusters social, economic and environmental impact, informing the development of any future strategy.

Figure 4 shows a breakdown of businesses within the Cluster. Highlighting the level of diversification that has taken place, industry constitutes 9% of businesses based within the Cluster by number, though utilising the vast proportion of land, noting the Port's strategic position for the distribution of cargo to market.

Having diversified to secure revenue exclusive from the fluctuations of the shipping industry, through a continually evolving portfolio of serviced office space and light industrial units, the Cluster has grown to become a hub for SMEs, now constituting the vast proportion of businesses within the Cluster.

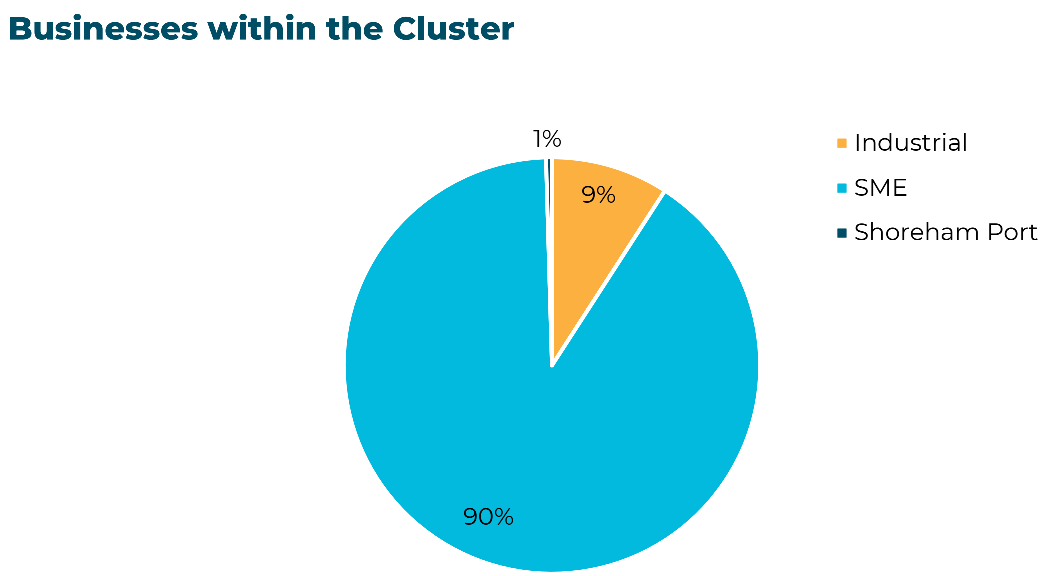


Figure 4 Business breakdown of the Shoreham Port Industrial Cluster

Working within the same categories utilised for survey distribution, Figure 5 shows a breakdown of businesses within the Cluster by sector. With prime aggregate resource areas located throughout the channel and vessels calling between Ports along the central South Coast, the aggregate industry constitutes the bulk of industrial tenants within the Cluster, contributing the dominant proportion of cargo year on year. With steel and timber further key cargoes for the Port, the processing, haulage and use of construction materials form the bulk of industrial activity and business across the Port, supporting construction and civil engineering across the region.

Located close to eastern fishing channels and with several projects underway at the time of writing to enhance and sustain fishing facilities within the port, fishers constitute a notable proportion of business, with angling, inshore, commercial and wholesale fishing catered for.

Making best use of the smaller, light industrial units across the Port, businesses for whom warehouse space is key and those requiring office space can be seen to form the bulk of SMEs within the Cluster, as further reflected in Figure 6. Understanding why businesses seek to position themselves within the Cluster, the research conducted highlighted that whilst industrial tenants are inevitably attracted to quayside and services, many SMEs favour the Port for its community, environment and proximity to Brighton, whilst still maintaining connectivity. Longstanding relationships with varied local businesses, charities and civic institutions position the Cluster as a force for innovation and good, and a key centre for collaboration within the wider Sussex Region.

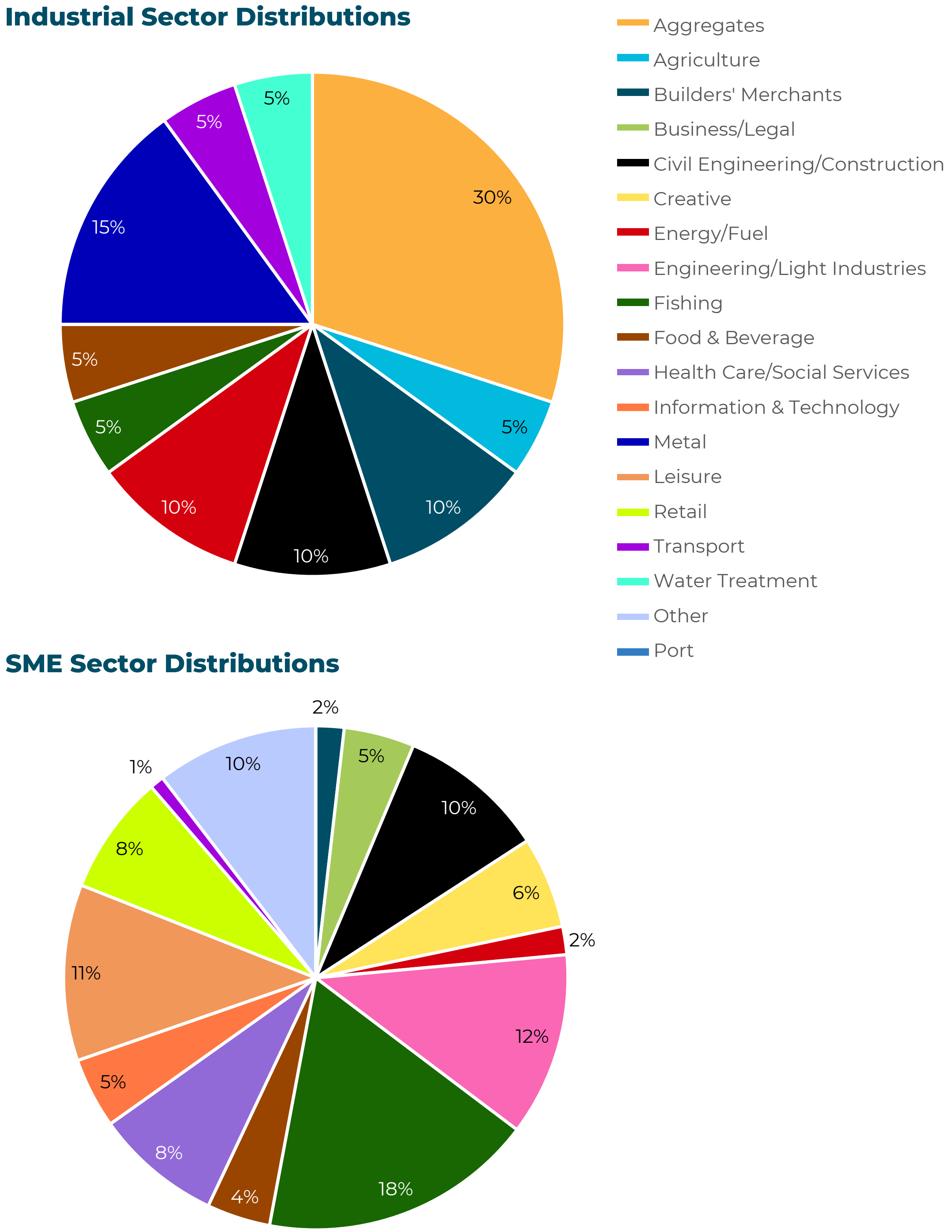


Figure 5 Sectoral breakdown of the Shoreham Port Industrial Cluster

6.3 Jobs Enabled

Providing critical employment and economic value to the region, the Shoreham Port Industrial Cluster supports over 1600 direct jobs, with a breakdown by employment figures provided in Figure 6.

Though the number of industrial businesses on-site represents a small proportion of the 200 businesses based within the Cluster, requiring skilled process, plant and machine operatives, these businesses offer valuable employment opportunities for many within the region, constituting a sizeable proportion of direct jobs within the Cluster.

With non-serviced industries 'including manufacturing, construction, agriculture and utilities' accounting for approximately a fifth of the UK's economic output, the long-term sustainability of these industries depends on and provides opportunity for a transition to green jobs. A further breakdown of both serviced and non-serviced jobs can be found in Figure 7.

Supporting over 230 direct jobs within the fishing industry, with potential to sustainably increase these numbers following the modernisation of fishing facilities and additional provision of berths within the Cluster, complete in January 2025, the Port continues to serve as a haven for day boat fishers and visiting commercial vessels. Managing the overall operation of the Port, as well as the bulk of timber cargoes, direct jobs under Shoreham Port Authority constitute 12% of total direct jobs, spanning numerous professions.

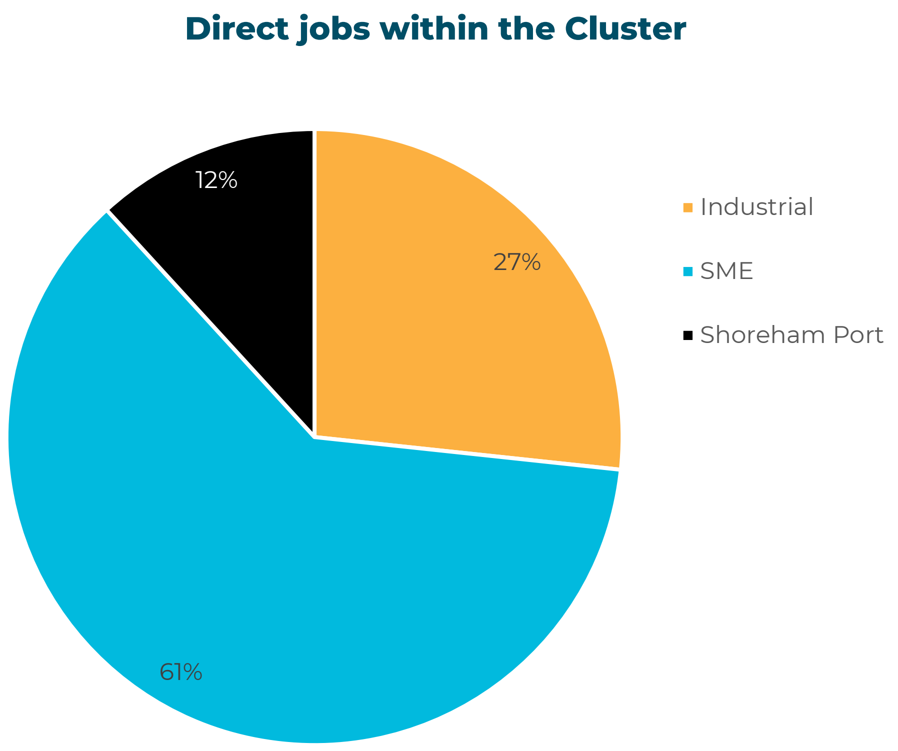


Figure 6 Direct job provision within the Shoreham Port Industrial Cluster

Acknowledging that for every direct job at the Port, numerous indirect jobs are supported, research on '[The Economic Contribution of the UK Ports Industry]' (Centre for Economics and Business Research, 2022), suggests over 10,000 further jobs are supported by employment within the Shoreham Port Industrial Cluster.

From the provision of fresh fish to construction materials, grain exports and employment opportunities for a diversity of sectors, the Cluster remains an economic asset for the region, supporting the local community through the provision of high-quality jobs that develop skills and encourage education, while also attracting investment.

Understanding the correlation between economic growth and emissions, when asked how businesses within the Cluster envisage their revenue changing against the milestone years associated with the rest of the plan, over 50% of SMEs and industrial businesses within the Cluster envisage a growth of approximately 10% within the next five years, a remarkably optimistic assessment in comparison to many macro forecasts.

Forecasting ahead to 2035, with Shoreham Port Authority's commitment to be Net Zero on Scope 1 and 2 emissions by then, an understanding of forecasted activity remains essential to informing a realistic decarbonisation plan for the Cluster and the diversity of businesses within it, with investment in industrial decarbonisation helping to directly support sustainable growth in revenue and hence job provision.

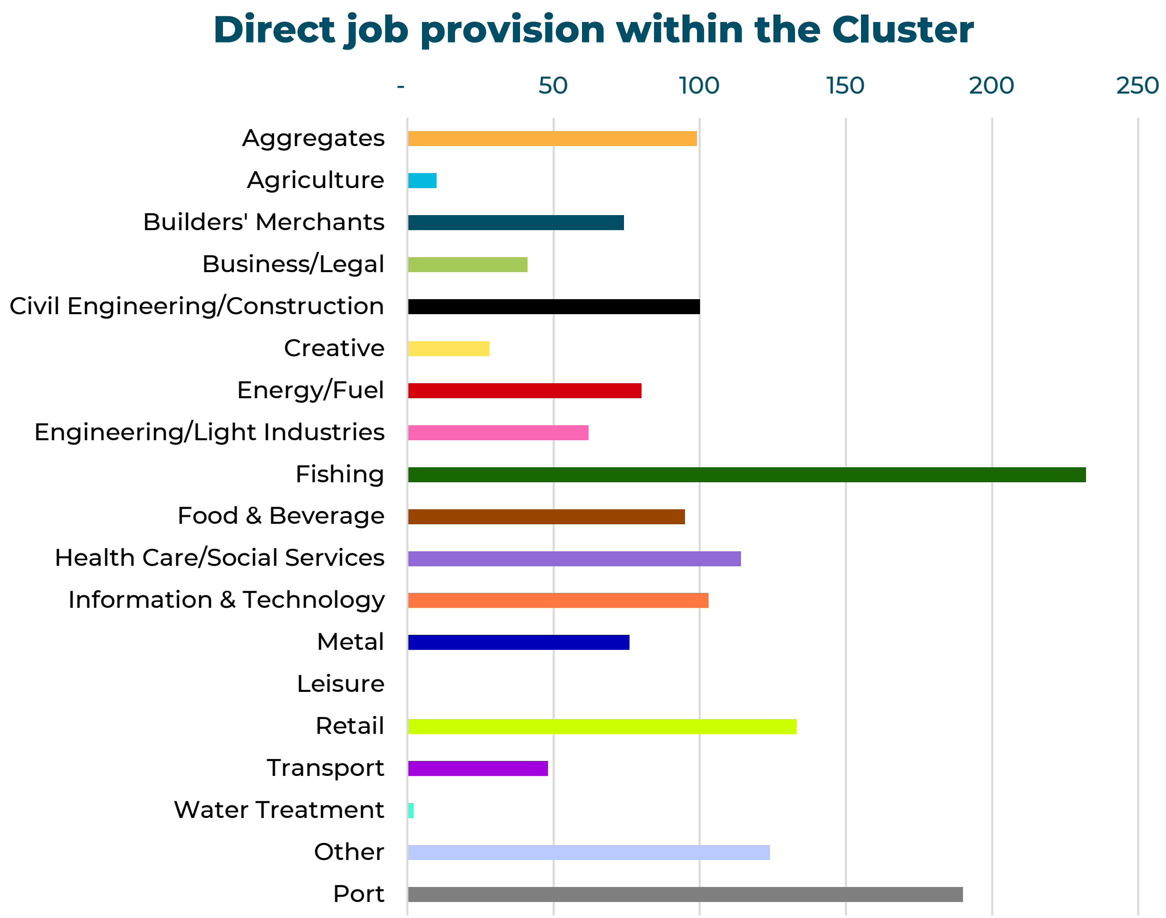


Figure 7 Direct Job Provision within the Cluster by sector

6.4 Community Challenges

The Shoreham Port Industrial Cluster borders several communities with significant challenges. Figure 8 depicts the low disposable annual household income experienced in Southwick (the base of the Cluster) compared to the England and Wales average. The Evidence Base for the Brighton & Hove Economic Plan 2024-27 states "Brighton & Hove has long been an attractive place to live, but it is difficult for middle-income earners to find somewhere to live comfortably within their means. For a median-income individual (£33,889/yr gross) looking to rent a one-bedroom flat, most options in the city would take up more than 30% of their pay".

Mean average equivalised disposable annual household income (£), before housing costs, for Southwick, financial year ending March 2020.

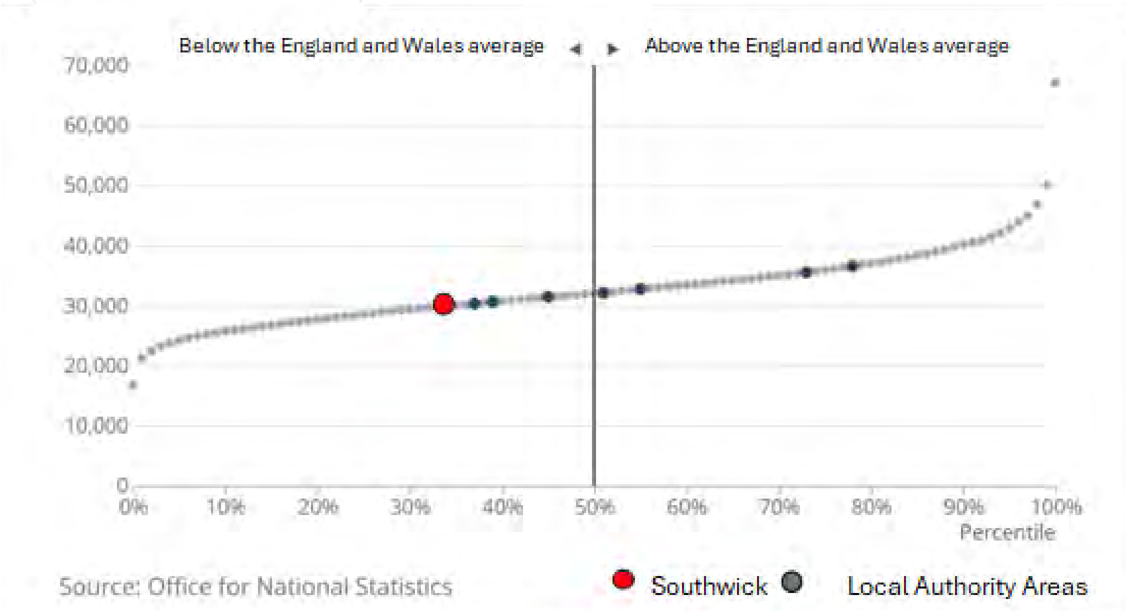


Figure 8 mean average equivalised disposable annual household income (£), before housing costs, for Southwick, financial year ending March 2020

6.5 Cluster Baseline

6.5.1 Current Energy Landscape

The key first step in producing an informed plan for Cluster decarbonisation is an understanding of the current energy landscape, with social-economic data shared in the previous section providing valuable context on both the current position and future forecasting. Using 2023 as a baseline, energy consumption by group is shown below.

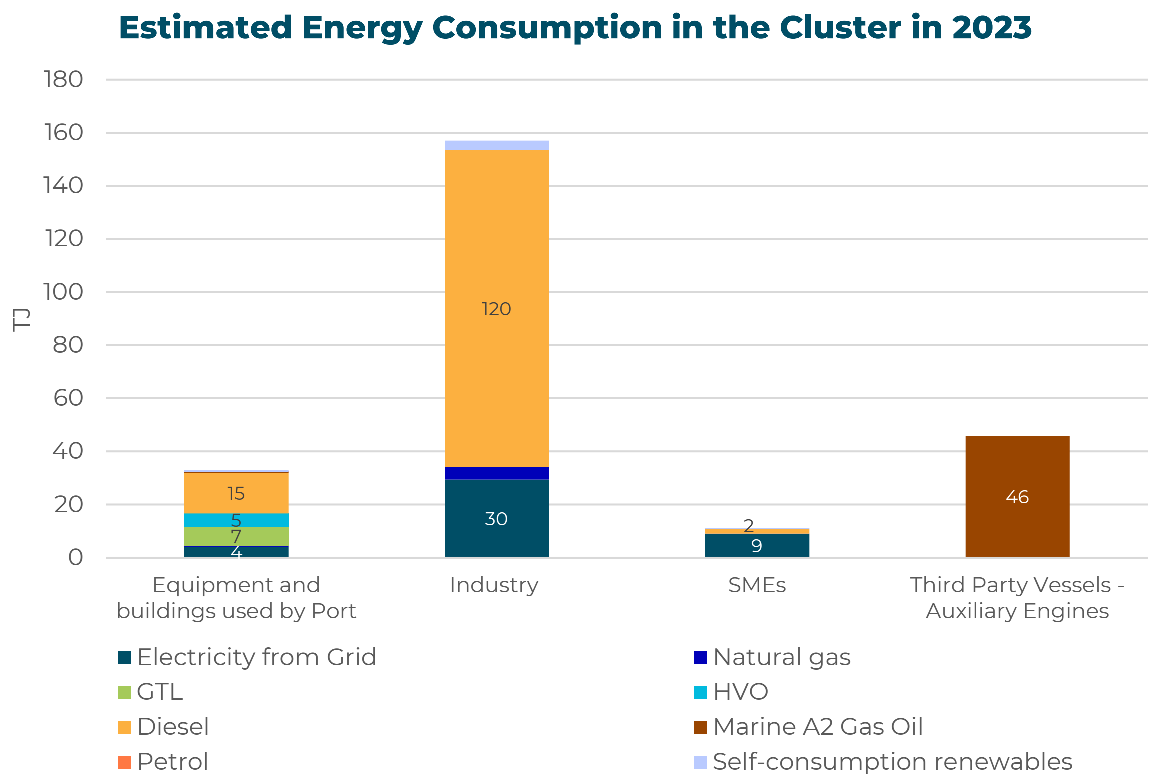


Figure 9 Estimated energy consumption in the Cluster in 2023, showing energy consumption in TJ

Accounting for almost 64% of energy consumption within the Cluster, industrial businesses based within the Cluster constitute the majority of energy demand, fuelling and powering operational equipment, warehouses and quayside. Though industry forms the majority consumer of electricity from the grid within the Cluster, the majority of energy demand by industry comes from their consumption of diesel to fuel HGVs and NRMM.

Having transitioned onto HVO in 2023, Port consumption of fuel adopts a similar trend, with Port activity constituting 13% of total energy demand within the Cluster. With a diverse array of SMEs around the Cluster, those businesses constitute a much smaller proportion of total energy demand, at 5% of total consumption. This is mostly grid electricity and diesel for light vehicles. Energy consumed by third party vessels while at berth is estimated to have accounted for around 20% of the consumption of the Cluster in 2023.

Assessing the Cluster in its entirety, it can be seen that the majority of power demand at present is from the grid, despite the 2.5MWp of solar available from arrays located across the Cluster and two 100kW wind turbines.

To illustrate the different fuel types by usage, Figure 10 below shows the energy baselines for 2023, as broken down by energy type and purpose.

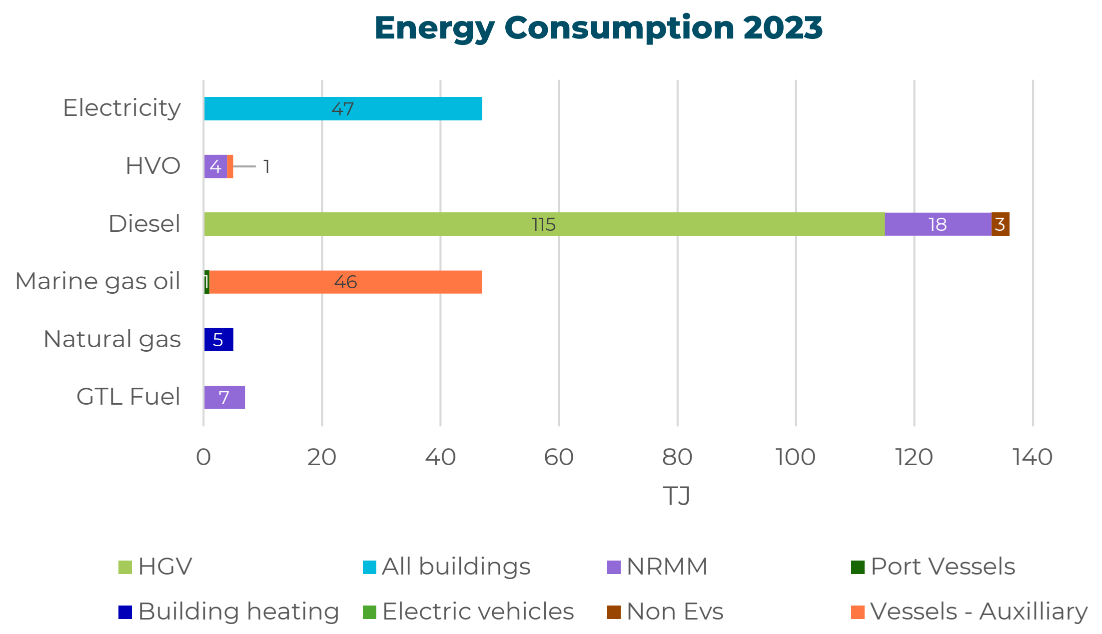


Figure 10 Energy Consumption by type across the Cluster for 2023

6.5.2 Current Emissions Sources & Profiles

Translating energy consumption into emissions, nearly 17,000 tonnes of CO_2e were emitted in 2023, with the model focusing on emissions generated as a direct result of on-site activity, hence including vessels whilst at berth, but not those emitted at sea. Similarly, with an average of 800 HGV movements per day within the Cluster, this model has elected to focus on NRMM and HGVs based at the Port. If the emissions of all visiting vessel journeys, third-party HGVs, NRMM and the on-site combined cycle gas fired power station had been considered, the recorded CO_2e emissions would be significantly higher. The logic for this segmentation is to focus this research on aspects the Cluster can directly influence.

Constituting the largest proportion of activity and energy demand on site, industry is responsible for approximately 60% of emissions generated within the Cluster, followed by third party vessels while at berth (21%), and then equipment and buildings used by Shoreham Port Authority. As broken down by contributor, HGVs and NRMM are predominant sources of emissions across both the Port and industry, with approximately 120 HGVs based on site and nearly 3.5 million litres of fuel consumed across the Cluster in 2023, presenting the largest scope to decarbonise. With total HGV movements per day averaging approximately 800 movements when including those of third-party HGVs, there exists clear potential to decarbonise not only on-site activity, but to act as a catalyst for HGV decarbonisation across the region.

With Shoreham Port Authority-operated HGVs working on a predominantly back-to-base model, decarbonisation efforts have already included the conversion of NRMM to HVO in 2024 and commencing in 2025, the gradual integration of HVO into the Shoreham Port HGV fleet. However, as is widely accepted within the industry, though enabling 80-90% emissions reduction compared to fossil fuels, HVO constitutes an interim solution while battery electric and hydrogen vehicles are developed and introduced, enabling the majority of Port decarbonisation to date, but with a finite timeline. This position was further evidenced during the year-long trial of HVO in a regular visiting cargo vessel, where the conclusion was again reached that this could not be sustained in the long-term for a combination of financial, logistical and environmental reasons.

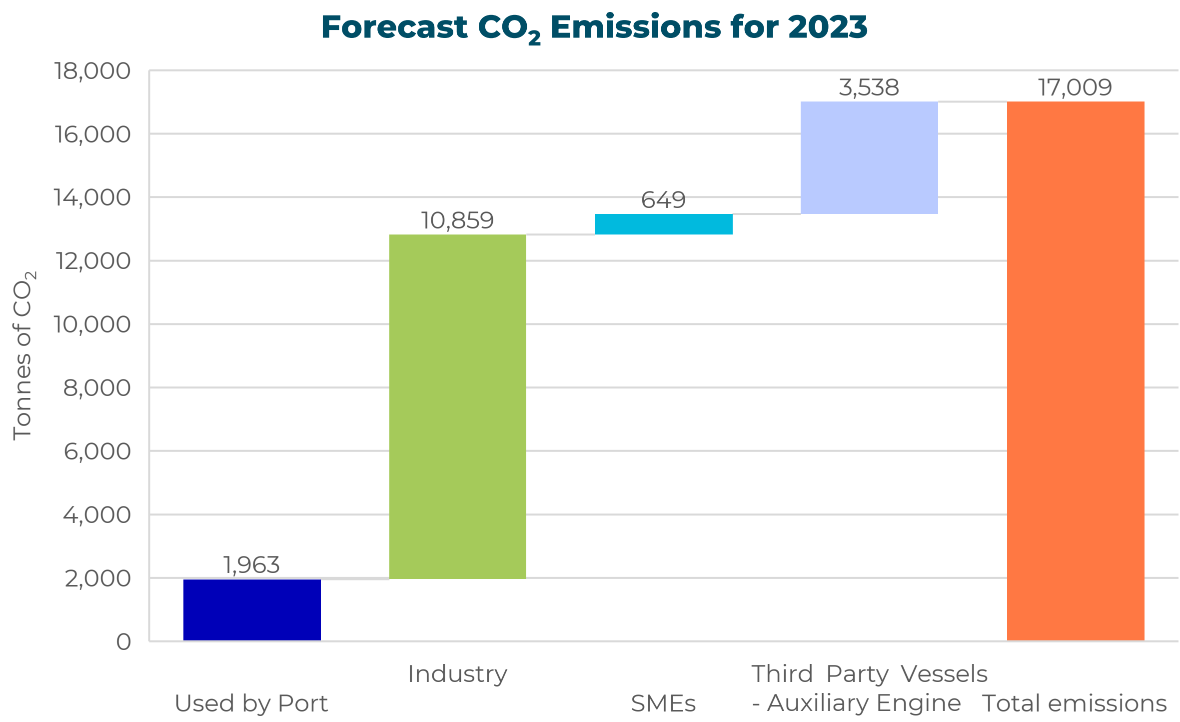
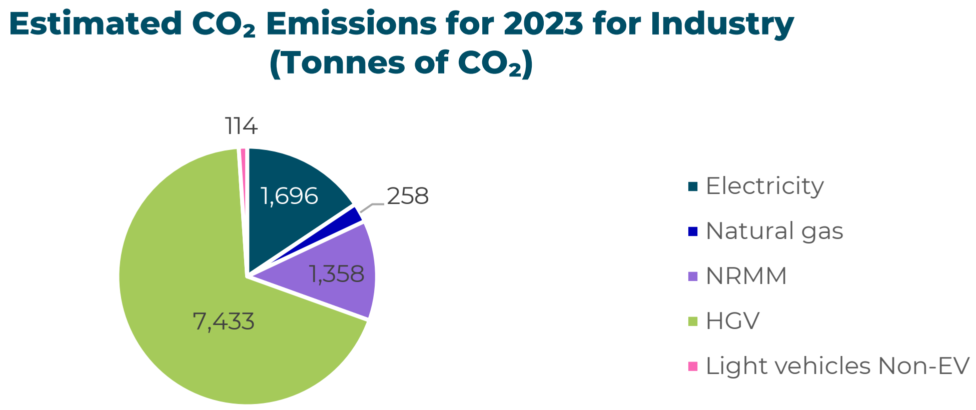
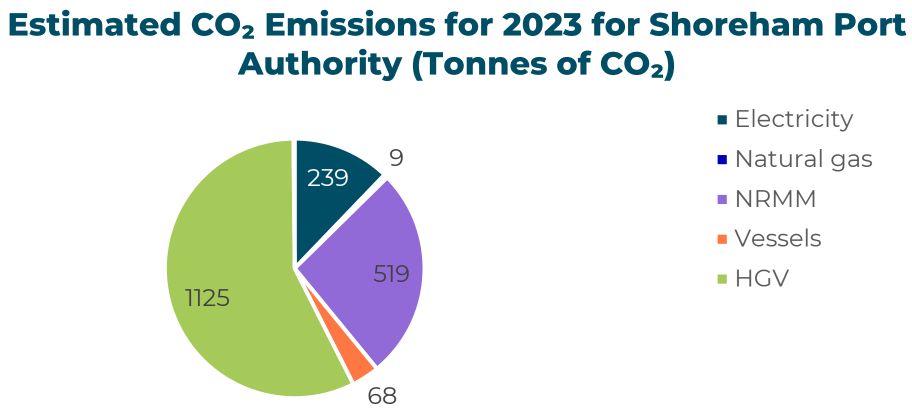


Figure 11 Forecast CO_2 emissions across the Cluster for 2023

Though the Port has been attached to a green electricity tariff since 2022, using electricity generated via renewables, to retain consistency and ensure the decarbonisation strategy identified is as well informed of energy requirements as possible, a figure of average grid intensity for the UK grid was used (0.207 kg CO_2/kWh11) in generating the emissions baseline for the Cluster, then assuming gradual decarbonisation of grid supplied electricity over time for future modelling. The rest of the emission factors used for other fuels are provided in the Appendix.

Figure 12 show the disaggregated estimates of the emissions by energy vector for Shoreham Port Authority operations in isolation (buildings and equipment operated and used by the Port), industry (not including the Port), and non-industry, highlighting further the significance of HGV operations.





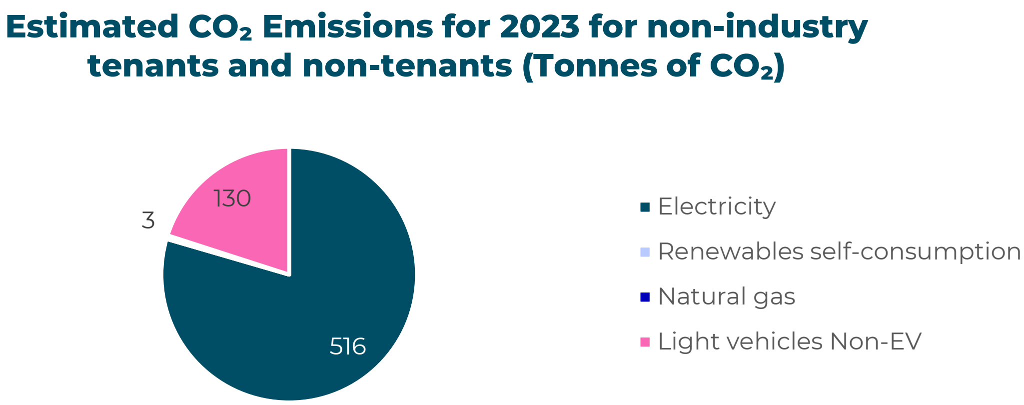


Figure 12 Estimated emissions breakdown across the Cluster for 2023

Pathways Modelled

7 Pathways Modelled

Continuing with the methodology outlined in section five, a summary of estimated energy requirements and emissions output across the Cluster are provided below, sharing valuable comparisons and initial indications of an optimal route for decarbonisation. The results of each scenario are then analysed in the following pages, comparing the estimated demand, supply, technical requirements and emissions output, to profile and compare the strengths and weaknesses of each scenario and provide crucial context on the design of an optimal route.

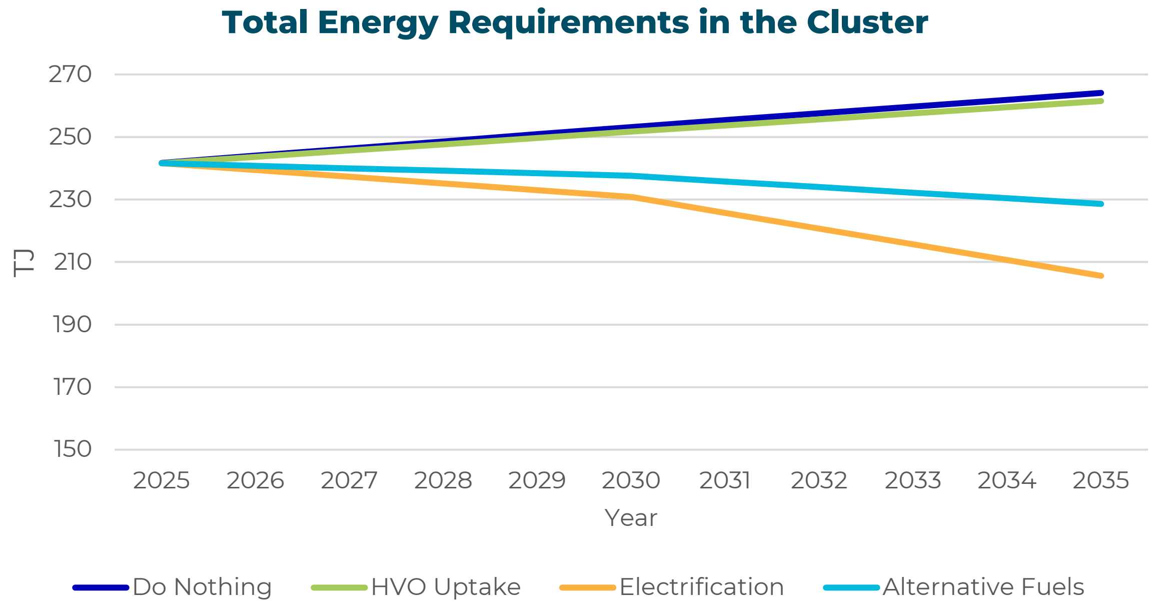


Figure 13 Total energy requirements across the Cluster, as forecast to 2035

Figure 13 illustrates the estimated energy requirements per year across the Cluster for all modelled scenarios, as contrasted against the 'do nothing scenario' for the benefit of comparison. Forecasting to 2035, as in line with the assumptions listed in section five, the following key points can be seen:

- Both the 'do nothing' and 'HVO uptake' scenarios show an increase in energy consumption across the forecast to facilitate a growth in cargo handling. The 'do nothing' scenario results in an increase in energy requirements of around 9% in 2035 relative to 2025, whilst the 'HVO uptake' scenario results in a growth of 8% in 2035 relative to 2025. The increase in energy requirements under both scenarios is a result of the additional use of NRMM required to handle the increased cargo and corresponding efficiencies of the two technologies.

- The 'do nothing' scenario has slightly higher energy requirements than the 'HVO uptake' scenario. This is because the 'HVO uptake' scenario includes energy efficiency gains from decarbonisation measures already undertaken by businesses within the Cluster, continuing on a projected trajectory and including measures such as the replacement of conventional lighting to LED and deploying EVs.

- The 'electrification' scenario draws the largest decrease in energy requirements within the Cluster, with efficiency assumptions estimating energy requirements could be almost 22% lower in 2035 relative to the 'do nothing' scenario. This decrease is due to the efficiency gains from switching to electric equipment, with efficiency assumptions provided in the appendix.

- The 'alternative fuel' scenario also shows a decrease in energy requirements due to the efficiency gains from switching some of the equipment to hydrogen, although the energy requirements do not drop as much as in the 'electrification' scenario. The energy requirements in the 'alternative fuels' scenario are estimated to be around 13% lower than the 'do nothing scenario' in 2035.

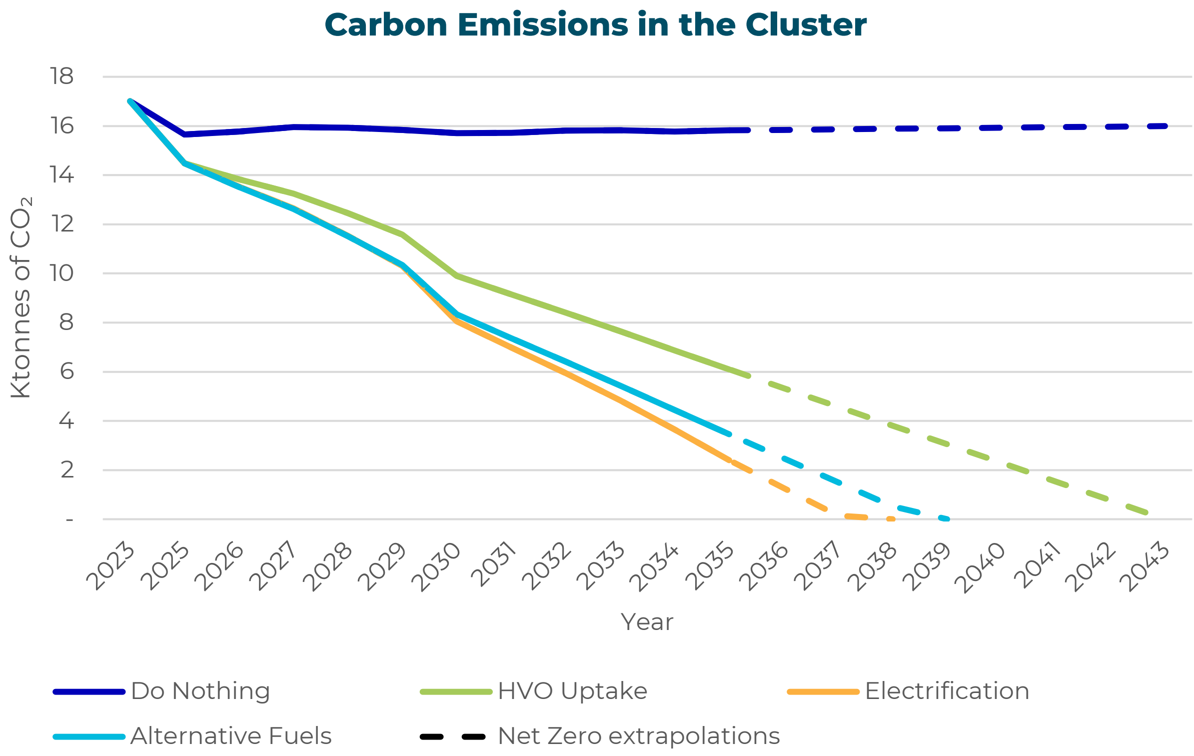


Figure 14 Total carbon emissions across the Cluster, as forecast to 2035

Figure 14 illustrates the estimated carbon emissions across the Cluster for all the modelled scenarios, as contrasted against the 'do nothing scenario' for the benefit of comparison. Key observations from the above figure include:

- All scenarios experience a drop in emissions in 2025 due to the introduction of Berth Zero and shore power for CEMEX Go Innovation.
- The 'do nothing' scenario could result in broadly unchanged levels of emissions throughout the forecast with a slight increase in emissions in 2035 relative to 2025 due to the additional fuel required for increased cargo handling (1% increase in 2035 relative to 2025).
- The 'do nothing' scenario produces higher levels of emissions than all other scenarios. For modelling purposes only, the scenario takes a step back from the emissions reduction progress already made around the Cluster, switching NRMM and marine vessels used by the Port back to diesel from HVO, so as to facilitate a valuable comparison and baseline of impact. Therefore, it should be remembered the Port is currently already making more decarbonisation progress than that shown in the 'do nothing' scenario.

- The ‘electrification’ scenario shows the largest decrease in emissions. We estimate that Cluster emissions could drop to 2.4 ktonnes of CO_2 by 2035, which is around 85% lower than the emissions under the ‘do nothing’ scenario. As discussed in section five the large decline in emissions is due to a combination of factors including the electrification of part of the NRMM and HGV fleet, the shift to using HVO for the remainder of the fleet, increased shore power, electrification of one of the port’s vessels, and higher renewable deployment and self-consumption. The compound annual growth rate (CAGR) of emissions for the Port alone is estimated at around -15% between 2025-2030.
- The ‘alternative fuel’ scenario has only slightly higher emissions than the ‘electrification’ scenario. Under this scenario, emissions could decline by around 78% in 2035, relative to the ‘do nothing’ scenario. This scenario has lower emissions than the ‘HVO uptake’ as it replaces all diesel consumption by 2035, whereas the ‘HVO uptake’ still has some of the NRMM and HGV fleet using diesel. The CAGR of emissions for the Port alone are estimated at around 13% between 2025-2030.
- The ‘HVO uptake’ scenario is not estimated to reduce emissions as much as the ‘alternative fuel’ and ‘electrification’ scenarios; however, it still shows that the pathway could lead to significant progress in decarbonisation. Under this scenario, emissions could drop to around 6 ktonnes of CO_2 by 2035, which is around 62% lower than the ‘do nothing’ reference. The CAGR for emission reduction for the Port alone is estimated at almost 4% between 2025-2030.
- Extrapolating the scenarios emissions and path to estimate the point of reaching net zero, projections indicate ‘electrification’ would reach Net Zero first, followed by the ‘alternative fuels’ scenario.

7.1 Scenario Modelling: Do Nothing

The 'do nothing' scenario considers a pathway for the Cluster where there is no further progress towards decarbonisation besides what is currently in the plan (i.e. Berth Zero and shore power for CEMEX Go Innovation). To create a baseline demonstrating decarbonisation progress from fossil fuels, the scenario swaps the Port's predominant fuel source back from HVO and onto diesel. Taking into account forecasted social and economic growth within the Cluster, growth in cargo handling is assumed, increasing the use of NRMM and HGVs to handle the additional cargo. The estimated energy requirements for the Cluster under this scenario are shown in Figure 15.

Energy Requirements

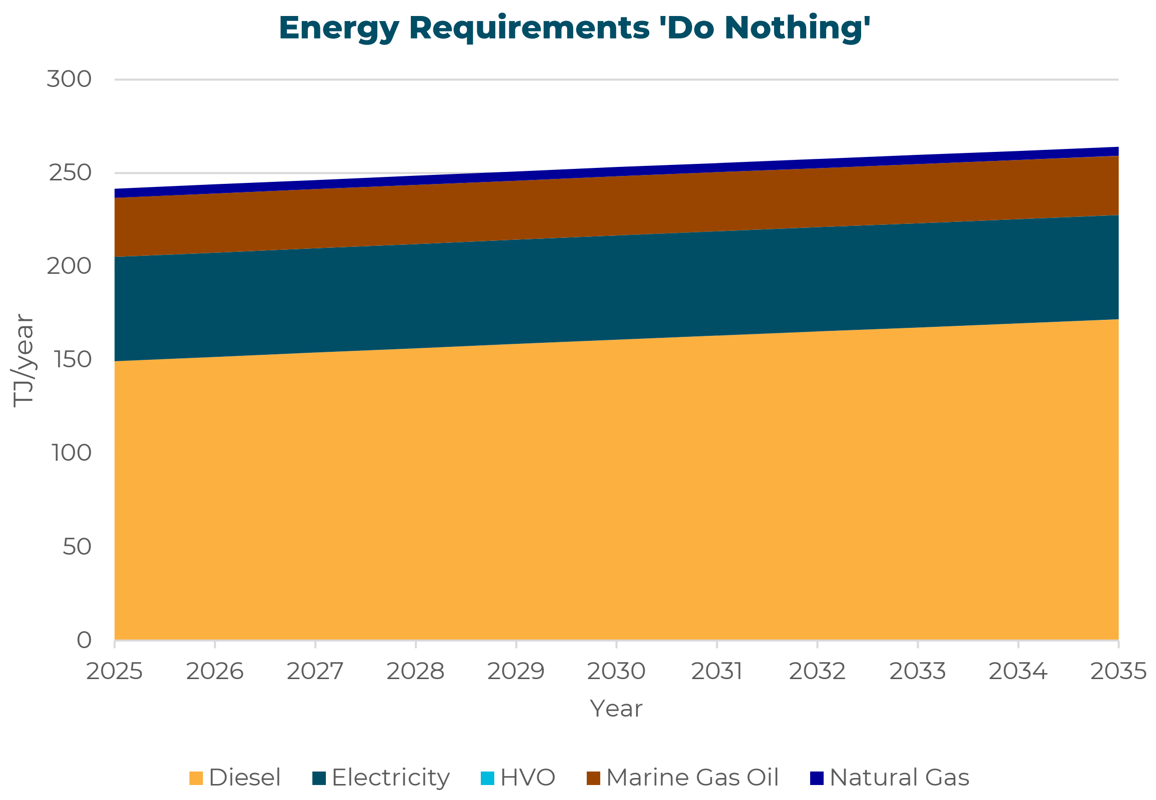


Figure 15 Energy requirements under the 'Do Nothing' Scenario, as forecast to 2035

From the figure above it can be seen that:

There is an overall increase in energy requirements throughout the forecast, due to growth in cargo handling within the Cluster, which increases the use of NRMM, and HGVs to handle the additional cargo.

Though diesel currently plays the largest role in the Cluster, accounting for over half of current energy requirements, the forecast shows a decrease of 63% by 2035, relative to 2025, with HVO energy requirements growing to form almost 50% of energy requirements in the Cluster by 2035, relative to current proportions of approximately 7% in 2025.

Emissions under a 'Do Nothing' Scenario

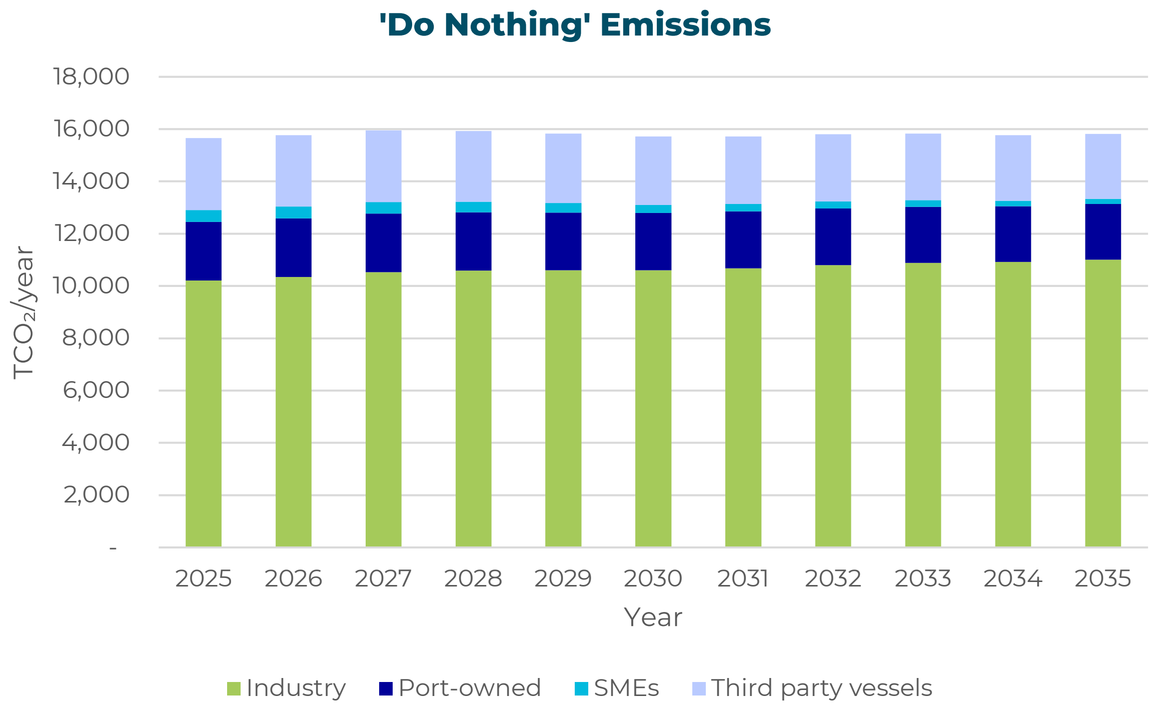


Figure 16 Emissions under the 'Do Nothing' Scenario, as forecast to 2035

Emissions in the 'do nothing' scenario only decrease by around 7% in 2035 relative to 2023, reflecting limited progress in decarbonisation due to the continuous use of diesel as the predominant fuel. However, even though emissions reduce relative to 2023, they increase relative to 2025 by around 1%. Despite the assumption that the UK's electricity grid will decarbonise throughout the time and therefore, importing electricity will reduce emissions over time, the continuous and additional use of diesel to handle the increased cargo in the Cluster still puts upward pressure on emissions relative to 2025. The emissions reduce relative to 2023 due to the implementation of projects such as Berth Zero and CEMEX Go Innovation in 2025.

As in line with the baseline emissions breakdown for 2025, emissions from industry continue to constitute the vast proportion of emissions generated across the Cluster under the 'do nothing' scenario, with those emitted via Port operations and third party vessels collectively representing the impact of industry and constituting on average 98% of the Clusters total emissions.

7.2 Scenario Modelling: HVO Uptake

Facilitating much of the Port's decarbonisation to date within NRMM and Port owned marine vessels, HVO has been gradually integrated into use across Port operations, representing the Port's current BAU approach to decarbonisation. Acknowledging that HVO will never be a permanent solution, as its uses expand to include industries such as aviation, the 80-90% emissions reduction this fuel provides has enabled the Port to take action now, constituting an interim solution to decarbonisation.

Though not widely used within the Cluster, some industrial tenants and Port users do currently utilise the fuel for NRMM and fleet vehicles, with one organisation having collaborated to trial the fuel in use of vessel servicing their Shoreham site. Having established a local supply chain with project partners 'Local Fuels', Shoreham Port Authority has sought to increase accessibility and fuel security for the Cluster and region, seeking to enable organisations to make the transition to HVO.

With the context provided above, this scenario looks to prolong the use of HVO, assessing the energy demand and emissions impact should the fuel be adopted across the Cluster, with the assumptions listed in section five explaining the blend of fuels outlined below.

Energy Requirements

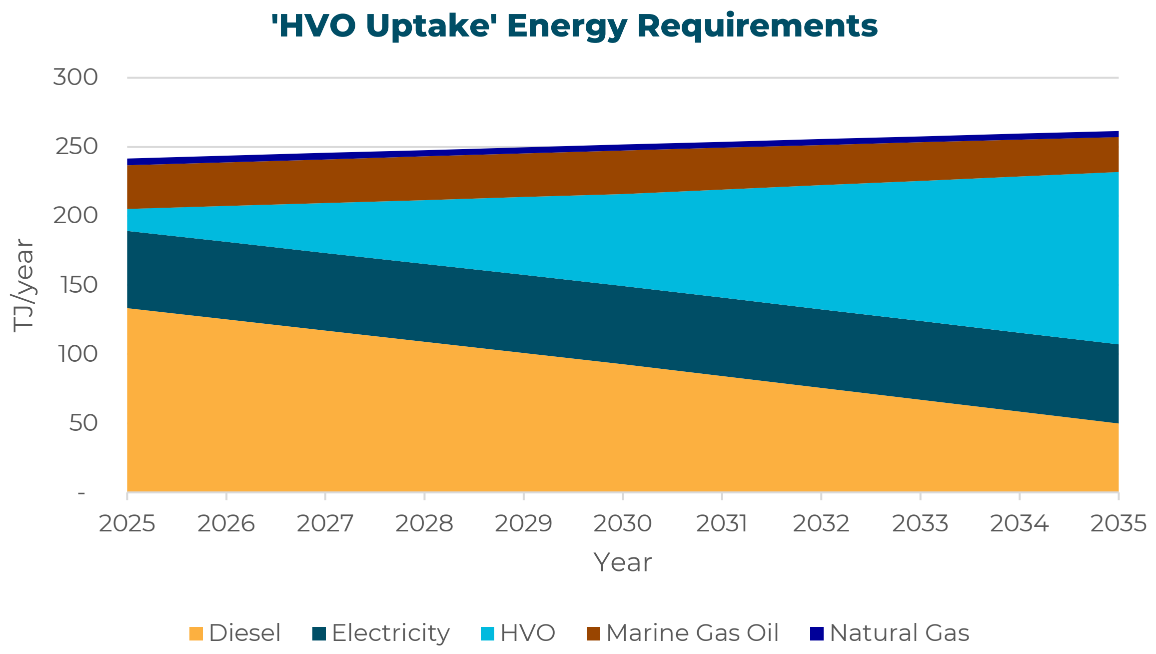


Figure 17 Energy requirements under the 'HVO Uptake' Scenario, as forecast to 2035

Figure 17 outlines forecasted energy requirements across the Cluster under the HVO scenario, with Figure 18 breaking energy demand up by energy vector. From these figures, the following observations can be made:

The move to roll out HVO across the Cluster as far as deemed feasible (under the assumptions listed in section five) inevitably sees increased use of HVO, predominantly from use in HGVs and NRMM. HVO energy requirements increase across the Cluster making up almost 50% of the energy requirements in 2035, relative to about 7% in 2025, whilst diesel consumption decreases by 63% by 2035, relative to 2025, decreasing from making up over 50% of the consumption in 2025 to below 20% in 2035.

Electricity consumption remains relatively similar throughout the forecast, only increasing by almost 3% from 2025 to 2035. This is predominantly due to EVs replacing conventional light vehicles across the Cluster where this has not already been done and the assumption that battery storage will facilitate storage of excess generation from renewables at times of low demand and use it at times of high demand and low generation, enabling greater self-sufficiency and less demand from the grid.

Overall energy requirements are increasing due to the combination of forecast growth in cargo handling, increasing the use of NRMM and HGVs operated by the Port in order to discharge and distribute cargo, whilst there are limited fuel efficiency gains from the fuel switching that occurs in this scenario.

The natural gas which remains in forecast is that used for metal manufacturing processes within the Cluster.

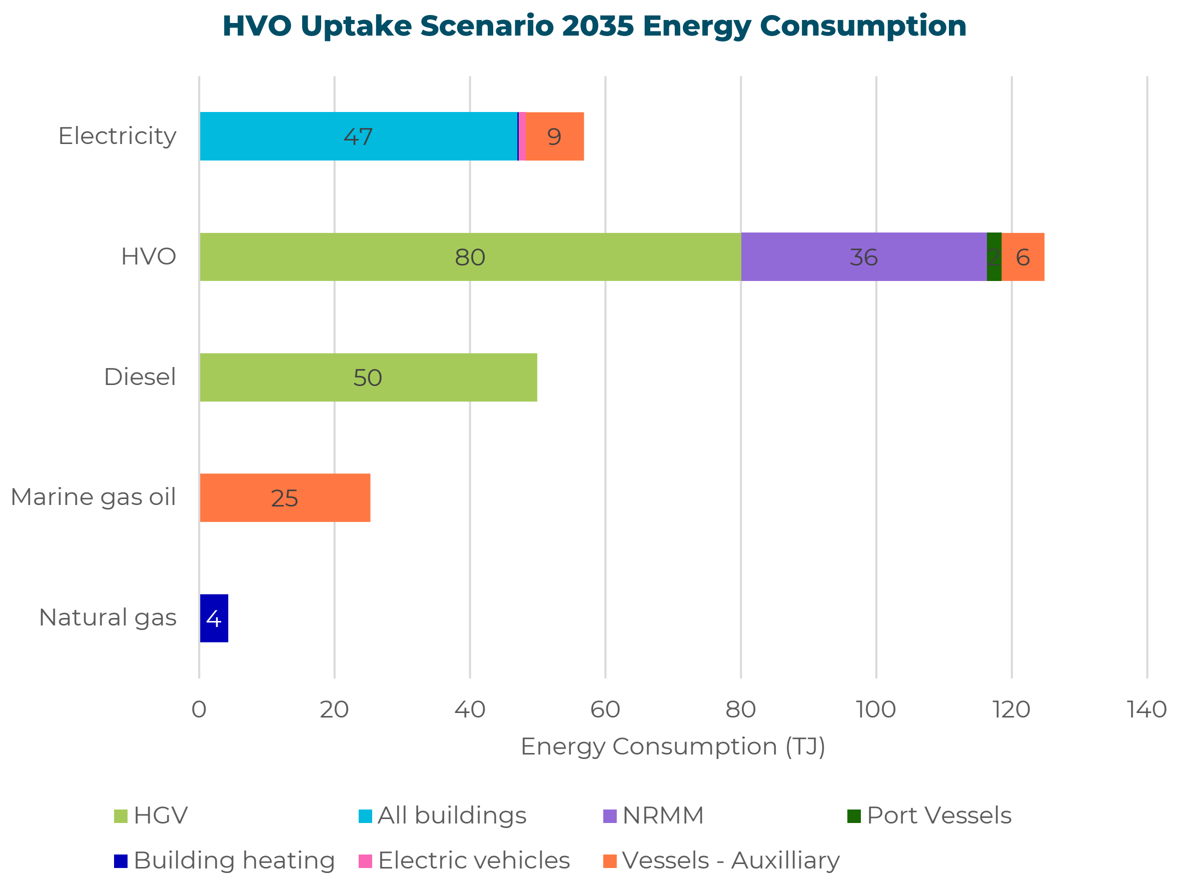


Figure 18 Energy Consumption across the Cluster, forecast to 2035, under the 'HVO Uptake' Scenario

Emissions under the HVO Uptake Scenario

Under the 'HVO uptake' scenario, an emission reduction of approximately 64% can be seen, relative to 2023, as made possible by the lower emission factor HVO possesses. Whilst the emissions factors used throughout this report are listed in the Annex, it should be noted the emissions factor of HVO can vary dependent on the fuel provider and batch composition.

From the below, we see that Shoreham Port Authority has minimal emissions by 2035 at under 50 tonnes of CO_2, a decrease of almost 98% relative to 2023. This is from the complete shift to HVO for all Port operated equipment, increased renewable consumption and further decarbonisation of the UK electrical network. Both SMEs and industrial organisations within the Cluster are seen to achieve notable decarbonisation, with SME emissions across the Cluster virtually eradicated and industry emissions reduced by approximately half by 2035.

However, noting the proportion of third-party vessels who service the Clusters quayside, with visiting commercial fishers who constitute the rest of that data set utilising the Ports provision of shore power following Berth Zero project completion in 2025, Figure 19 demonstrates that by 2035, under the HVO uptake scenario, industrial activity will continue to form the greatest contributor of emissions. These emissions, although greatly reduced from today's levels, are still present due to the assumed continued albeit reduced consumption of diesel and marine gas oil, respective of decarbonisation challenges faced within the haulage and commercial shipping sector. Full decarbonisation of commercial shipping sector requires considerable development from its current position, necessitating large-scale support and collaboration between vessel operators, government and policy makers, to support the transition and provide certainty around investment (International Chamber of Shipping [ICS], 2020). Without this, the risk and financial outlay required will remain unfeasible (ICS, 2020).

Though an achievable, drop-in, interim solution for decarbonisation, working well for onsite operations or haulage operating on a back-to-base model, it can be seen that the cost, demand and logistical constraints of HVO in haulage under current assumptions, and significant uncertainty regarding the decarbonisation of commercial shipping prevent the fuel from facilitating complete net zero across the Cluster.

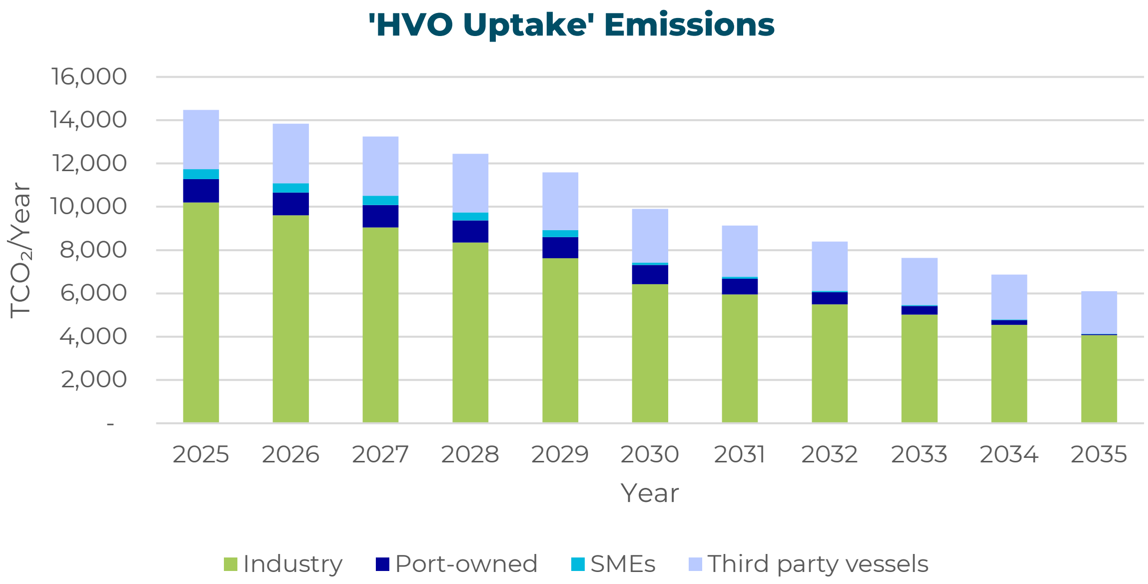


Figure 19 Emissions under the 'HVO Uptake' Scenario, as forecast to 2035

7.3 Scenario Modelling: Electrification

The 'electrification' scenario outlined below considers gradual electrification of a proportion of plant equipment and NRMM within the Cluster, the replacement of gas boilers and further roll out of electric fleet vehicles in place of conventional light vehicles, which remain in use across the Cluster by many organisations. The model also assumes the continued roll out of renewable assets, including battery storage aligning generation with demand, and energy management. As noted in section five, this scenario assumes that up to 50% of the fuel used by NRMM and HGV fleet is electrified by 2035, whilst the remainder of the fleet runs on HVO, as informed by extensive technical and financial analysis and assumptions.

Energy Requirements

The energy requirements estimated for this scenario are illustrated in Figure 20 and show that:

Through gradual replacement of operational equipment and fleet vehicles with electrified alternatives, the use of diesel across the Cluster can be completely negated by 2035.

As outlined in the previous section, though shore power introduced to the Cluster in 2025 will support the decarbonisation of the commercial fishing fleet, uncertainties within future fuels within the shipping sector make further decarbonisation a significant challenge. Hence the scenario assumes a reduction of 20% in marine gas oil consumption by 2035, relative to 2025.

Electricity consumption increases by a little over 65% by 2035, relative to 2025, increasing from making up almost 23% of energy consumption across the Cluster in 2025 to around 45% in 2035. Reducing dependence on fossil fuels, this transition is made possible by an increase in renewable energy generated across the Cluster, with battery storage enabling the storage of excess generation of renewables at times of low demand and use it at times of high demand and low generation.

To account for the remaining demand across the Cluster which electrification cannot feasibly be seen to supply by 2035, respective of technical and financial assumptions including grid connection delays, HVO consumption across the Cluster would have to increase by almost 500% compared to current consumption in 2035. The significance of this can best be seen in Figure 21, highlighting energy requirements by energy vector across the Cluster

Overall, energy requirements decrease across the forecast horizon by around 15% by 2035, relative to 2025. Even though there is an overall growth in NRMM usage and number of HGVs operated by the Port, there is a net energy reduction from switching a large portion of the fleet to run on electricity, taking into account the efficiencies an electric drive train facilitates, compared to engines ran on conventional fossil fuels.

Similar to the 'HVO uptake' scenario, the natural gas that remains in the forecast is that used in industrial manufacturing processes. The electrification of this gas consumption was not considered but is estimated to require 300-400MWh of electricity to replace.

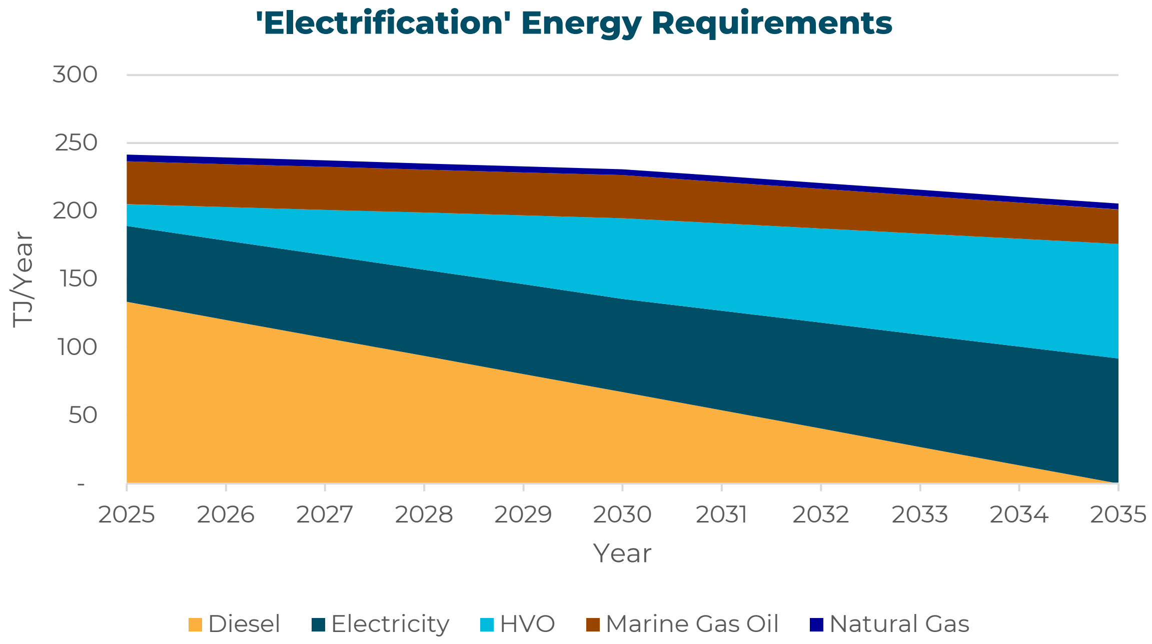


Figure 20 Energy requirements under the 'Electrification' Scenario, as forecast to 2035

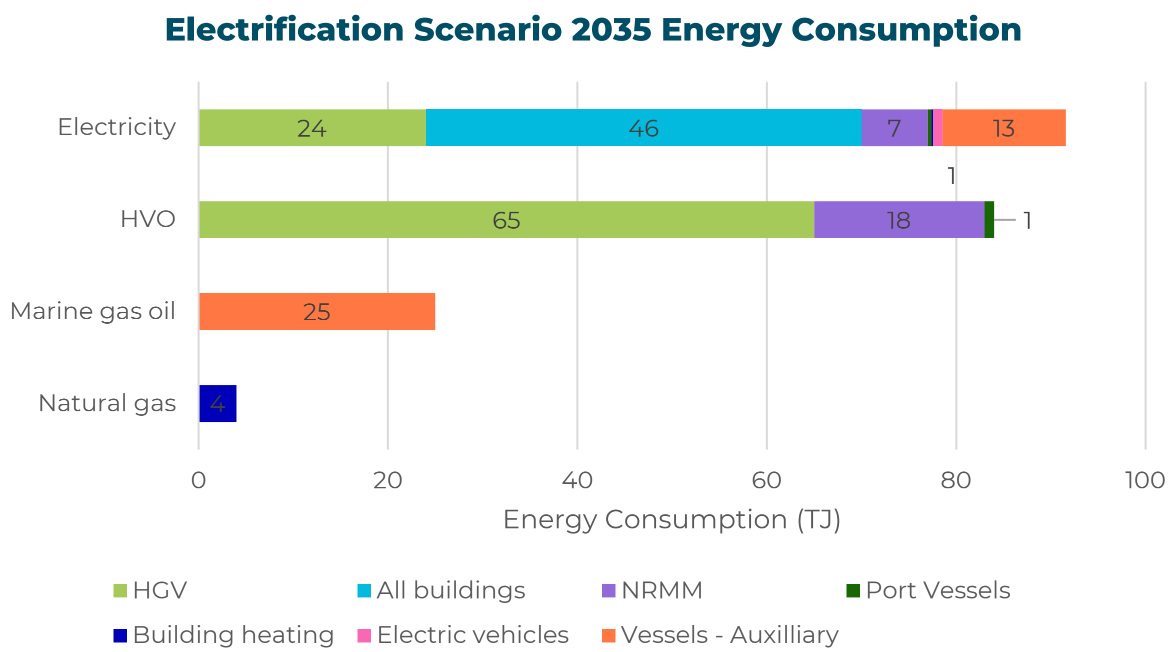


Figure 21 Energy Consumption across the Cluster, forecast to 2035, under the 'Electrification' Scenario

Emissions under the Electrification Scenario

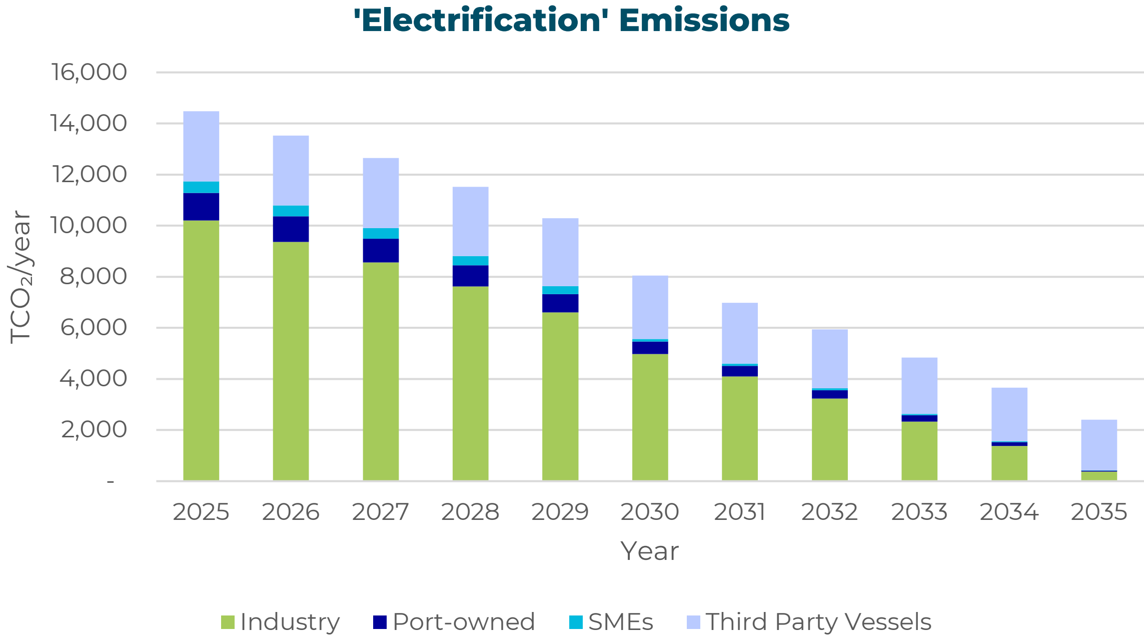


Figure 22 Emissions under the 'Electrification' Scenario, as forecast to 2035

Under an electrification scenario, utilising HVO to facilitate the decarbonisation of emissions across aspects of the Cluster not yet considered feasible to electrify respective of technical and financial assumptions, an emissions reduction of approximately 83% can be seen by 2035 relative to 2025 and 86% relative to the 2023 baseline. This decrease is due to the electrification of a large portion of the HGV and NRMM fleet in the Cluster, in addition to shore power.

The swap to electrification reduces emissions due to the lower energy requirements from using a more efficient system (as previously discussed) but also from the lower emissions assumed surrounding electricity. The model also accounts for higher self-consumption from renewables (with zero emissions) in the Cluster due to the continued roll out of renewable assets, including battery storage aligning generation with demand, and energy management. Furthermore, the scenario assumes further decarbonisation of the UK's electrical grid, reducing emissions when importing electricity.

Similar to the 'HVO uptake' scenario, electrification makes possible considerable reduction of emissions stemming from Shoreham Port Authority itself, with less than 40 tonnes of CO_2 forecast by 2035. Furthermore, under this scenario the emissions stemming from industrial stakeholders would also be reduced considerably, due to the complete replacement of diesel in operational equipment with HVO. With industrial emissions constituting the bulk of emissions generated by the Cluster, the combination of technologies considered under this scenario remains realistic of grid upgrade timelines and financial assumptions, implementing technologies already proven within the Cluster, and at a lesser cost than other alternatives, as outlined in sections five and eight.

Again, as with the HVO scenario, emissions from the gas consumption used for industrial processes have remained. As with other scenarios, the predominant remaining source of emissions by 2035 continues to be those emitted by vessels running their auxiliary engines at berth using marine gas oil (accounting for around 82% of emissions by 2035). Owing to uncertainties around vessels switching fuel types, it remains an immense challenge for both vessel operators and any Port or surrounding bunkering facility to invest in decarbonisation, due to risk of stranded assets at considerable cost (ICS, 2020). However, should appropriate policy and incentives evolve to initiate this process and provide clarity and direction on the decarbonisation of shipping, it is likely the remaining proportion of emissions may well be reduced and eventually eradicated, achieving complete net zero for the Cluster and reducing a considerable proportion of global emissions.

7.4 Scenario Modelling: Alternative Fuels

Exploring the feasibility and impact of replacing diesel and marine gas oil with a combination of HVO and alternative fuels such as methanol and hydrogen, the final scenario utilises the input assumptions outlined in section five, to assess the energy requirements and emissions output of a combination of alternative fuels. Remaining aware of the current rate of development, deployment and supporting uptake of alternative fuels, this scenario assumes that 50% of the HGV and NRMM fuel consumption in the Cluster switches to hydrogen (including dual-fuel cranes), whilst 20% of the fuel used by third-party vessels is methanol and two of the Port's vessels (i.e. one tugboat and one pilot cutter), run on methanol, with the remainder continuing to use marine gas oil. The ratios of methanol and hydrogen, and their use-cases (vessels or equipment) would in reality depend on future economics and commercial readiness, with switching between them having little effect on the results.

Energy Requirements

The energy requirements estimated for this scenario are illustrated in Figure 23.

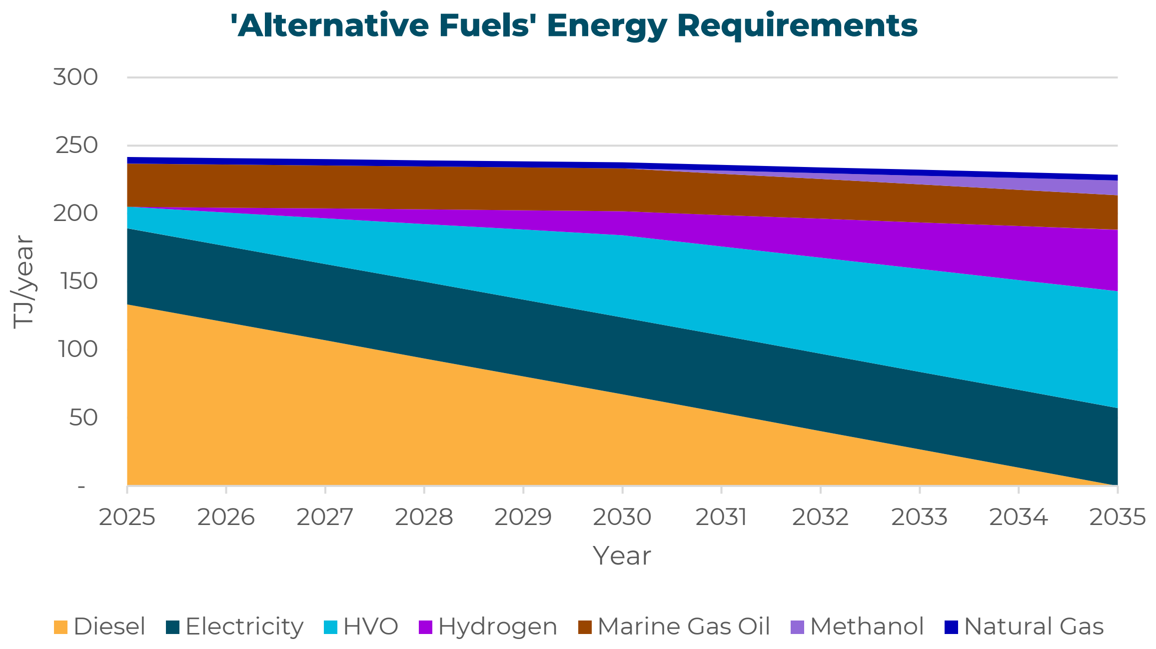


Figure 23 Energy requirements under the 'Alternative Fuels' Scenario, as forecast to 2035

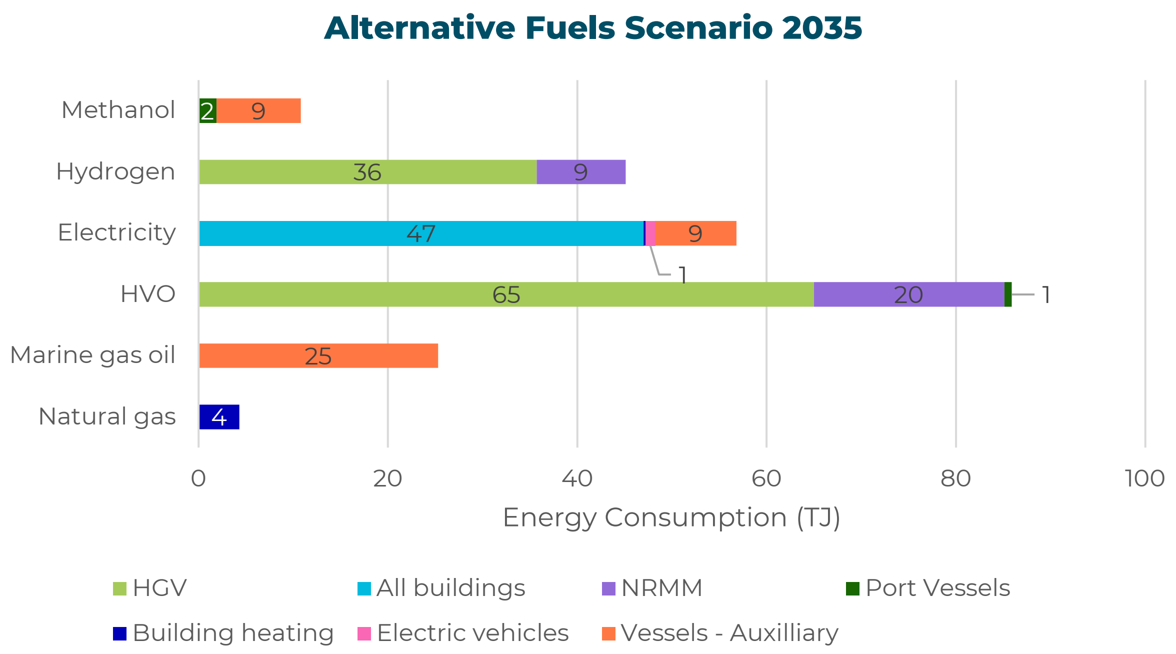


Figure 24 Energy Consumption across the Cluster, forecast to 2035, under the 'Alternative Fuels'' Scenario

Some of the key observations from the figure above include:

Across the ten year period forecasted, there is growth in consumption of methanol, HVO and hydrogen, replacing the use of diesel in its entirety by 2035 and enabling a gradual reduced dependence on marine gas oil, with assumption assumed to fall by 20% relative to consumption for 2025.

The integration of hydrogen and methanol is gradual, with uptake growing steadily to 2035, forecasting that hydrogen would make up almost 20% of energy consumed and methanol constituting approximately 5% of energy requirements in 2035.

HVO consumption is assumed to be almost five times higher in 2035 than in 2025, as with the electrification scenario, providing a low emissions alternative where the roll out of hydrogen and methanol at scale is not yet considered feasible.

Electricity consumption remains relatively similar throughout the forecast, increasing by almost 3% from 2025 to 2035, predominantly due to EVs replacing conventional light vehicle fleets across the Cluster. This is the same as that in the 'HVO uptake' scenario, owing to a similar level of electrification being forecast, with the deployment of battery technology facilitating storage of excess energy, to be used at times of high demand and low generation.

Similar to the other scenarios, the remaining gas in the forecast is used for industrial manufacturing processes.

Overall, the integration of alternative fuels makes possible a reduction in energy requirements of approximately 5% by 2035, relative to 2025, with Figure 24 highlighting energy consumption by fuel type. Even though there is an overall growth in NRMM usage and number of HGVs operated by the Port, there is a net energy efficiency gain from switching a large portion of the fleet to hydrogen, highlighting the valuable role hydrogen has to play in a more efficient and environmentally friendly future for industry. It has been assumed that forklifts and HGVs use fuel cell technology, and therefore, there are energy efficiency gains, with fuel cell technology considered to be around two times more efficient than engines running on conventional fossil fuels.

Emissions Reduction under the Alternative Fuels Scenario

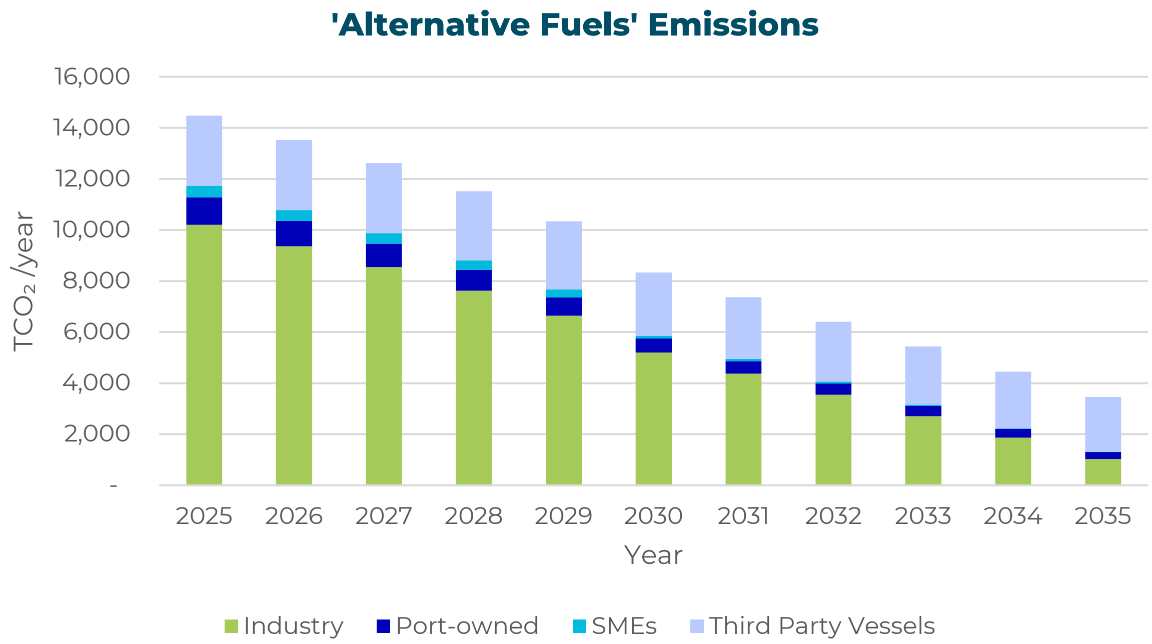


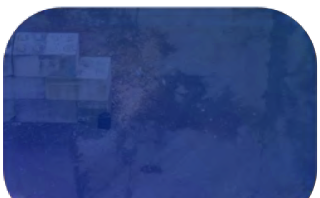
Figure 25 Emissions under the 'Alternative Fuels' Scenario, as forecast to 2035

Integrating a blend of alternative fuels across the Cluster, remaining realistic of current and anticipated development, deployment, uptake rates and availability, the adoption of alternative fuels can be seen to enable a Cluster wide emissions reduction of almost 80% by 2035, relative to 2023 levels. By transitioning to green hydrogen and HVO in NRMM and HGVs, and integrating green methanol into the Port's own marine vessels and assuming some uptake in third party vessels, the scenario can be seen to achieve similar results proportionally to that achieved by electrification.

Though the majority of commercial cargo vessels calling at the Port have travelled from Europe, these journeys can still take days. As complimented by continual progress in renewable uptake across the Cluster and the Ports existing shore power project, the scenario acknowledges further reduced emissions due to higher electricity self-consumption from the increased deployment of renewables and energy management assumed.

It is noted that several hydrogen production projects have been initiated within the Cluster, these feasibility studies have then not progressed to full investment decisions, a trend replicated across the energy sector (Palladino 2024, Martin 2024). The outputs of this research, the industrial nature of the location, land availability, diverse use cases within the Cluster, growing hinterland demand, renewable expansion potential and proactive Local Authorities all create very positive conditions for the development of a project when market conditions are considered favourable. The forthcoming UK Governments hydrogen allocation round 3, anticipated in mid 2025 is certainly an opportunity for the Shoreham Port Industrial Cluster should an appropriate project come forward.

Implementation



8 Implementation

8.1 Our Optimal Pathway

Understanding the opportunities and respective challenges each scenario presents, the modelling undertaken in the previous section has outlined the emissions reduction possible under several different technologies and alternative fuels. Developing each scenario within the context of a fluid political, technological and financial landscape, key assumptions have been made to inform a plan which is realistic and viable. It is however important to acknowledge that as the landscape we operate in changes, the development, uptake and deployment of decarbonisation technologies may evolve to progress, delay or evolve any of these scenarios. Indeed, it remains likely the final path followed will combine elements from each scenario, respective of growth, supporting policies and infrastructure, availability of capital and overall costs.

However, by assessing the requirements, benefits and trade-offs of each scenario, we have been able to understand an optimal emissions reduction pathway within the context of current and future assumptions and are well-positioned to advance towards deployment.

Highlighting electrification as the optimal decarbonisation scenario for the Cluster under the series of assumptions made in this study, electrification would lead to the fastest emissions reduction of all three scenarios modelled. This pathway would include:

- Essential modifications to the Cluster's electricity grid, enabling the sharing of increased renewable electricity across the estate and between the largest users, together with consumption of excess electricity from the existing renewable assets. The benefits of the electrification scenario are dependent on unlocking the ability to share electricity generation, storage and use across the Cluster. This will require constructive discussion with the local DNO and supportive policy, potentially including investment.
- Transitioning 50% of fuel consumed by NRMM and HGV across the Cluster to electricity by 2035, with the remaining 50% using HVO.
- Shoreham Port Authority electrifying at least one of its works boats by 2035, remaining heat and continued implementation of LED lighting.
- All light vehicles operated by businesses within the Cluster being replaced with EVs by 2035
- The opportunity to extend the roll out of shore power, enabling further vessels to access electricity as opposed to running auxiliary engines at berth.

Reducing dependence on national infrastructure, the pathway would include deploying more renewables including:

- An additional 4.8MW of solar PV by 2035, with 1.5MW developed by 2030, on rooftops and land across the Cluster. The Outer Layby has the highest potential at over 1MW, followed by the Brighton Terminal sites and Inner Layby.
- 6-8MW of onshore wind along the southern Port boundary by 2035 with 5MW installed by 2030.

- 18.4MWh of battery storage commissioned by 2035, assuming a 4-hour battery, which equates to 4.6MW of battery storage (with 1.9MW commissioned by 2030 and another 2.7MW commissioned by 2035). The area required for the battery installation is estimated to be around 0.17 acres, or 700m².

The key contributors to emissions reduction for the 'electrification' scenario in 2035, relative to the 'do nothing' and 2023 emissions baseline are estimated and illustrated in the figure below. These are estimates as some of these drivers are difficult to isolate.

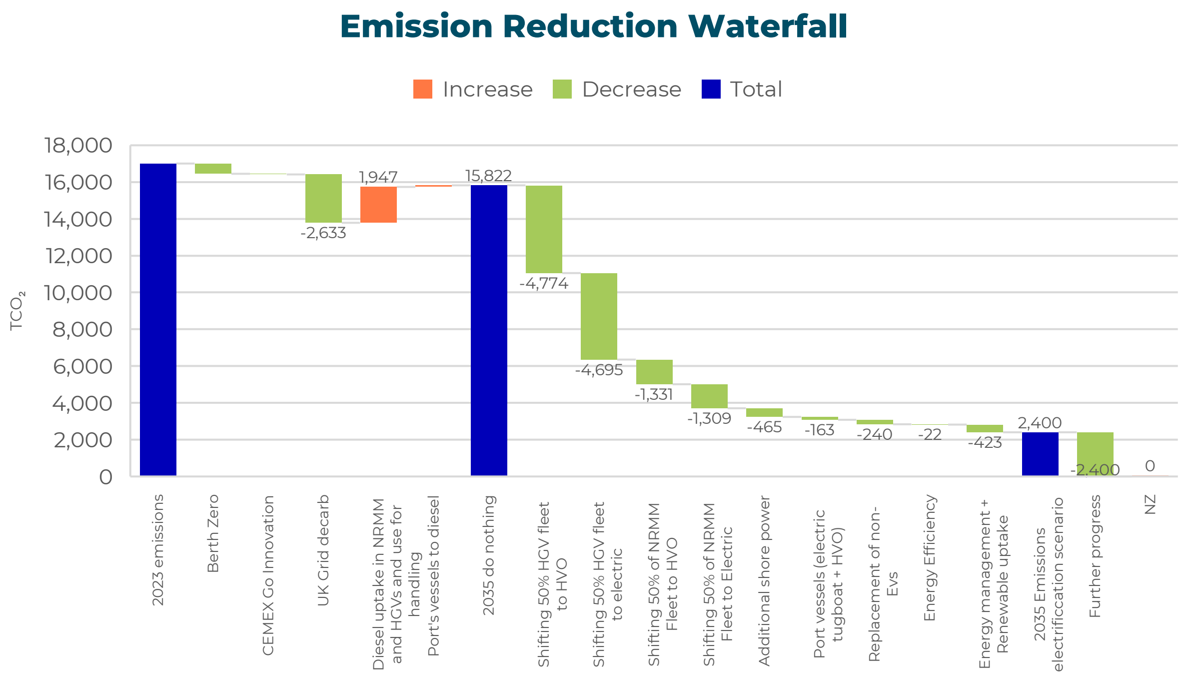


Figure 26 Achieving Net Zero in the Shoreham Port Industrial Cluster

Though the modelling identifies the 'electrification' scenario as the most beneficial decarbonisation strategy, it is important to consider that the results are linked to the underlying assumptions of this study. The benefits and costs could vary depending on how the fuel prices, technological development, and demand progress into the future and how the Cluster itself evolves. Collaborating with our partners and stakeholders as we move forwards towards implementation and deployment, this plan will remain a living document which is frequently updated to account for the evolution of the market and Cluster.

Although the current analysis prioritises electrification, it will be prudent for the Cluster to keep abreast of relevant hydrogen and alternative fuel developments, given the positive attributes reinforced through the research for the Cluster to host a production facility. This could include trials of methanol and hydrogen vessels and equipment in parallel to the continued feasibility studies into hydrogen production within the Cluster.

With agility in mind, the Cluster could begin by proceeding with projects that are shared across scenarios and could be deployed without risk of stranded assets, for example, the renewable energy projects, electrical connection modifications and increased HVO uptake. All scenarios show that by 2030 there is a value in growth in onshore wind of at least 4MW, growth in solar of at least 1.5MW and at least 1.4MW of battery storage (assuming 4-hour battery).

Proceeding with these developments will enable progress towards decarbonisation whilst also allowing the Cluster to remain flexible to the evolution of hydrogen and its respective markets.

8.2 Next steps

The research and analysis conducted under this Local Industrial Decarbonisation Plan has shown that net zero can be achieved for the Shoreham Port Industrial Cluster, identifying an optimal pathway and series of projects by which decarbonisation can take place. Remaining ambitious but realistic, the plan has been developed within the context of a fluid political, technological and economic landscape, identifying a combination of smaller projects, through to advanced infrastructure changes. To advance with this plan and implement the changes identified a series of next steps, requiring investment, support and further collaboration are required.

In addition to the emissions impacts and energy requirements, a major factor at play in determining how this plan progresses into deployment is cost and relative benefits.

The total investment costs for each scenario, for the period 2025-2035, as compared against the 'do nothing' scenario are shown in the figure below.

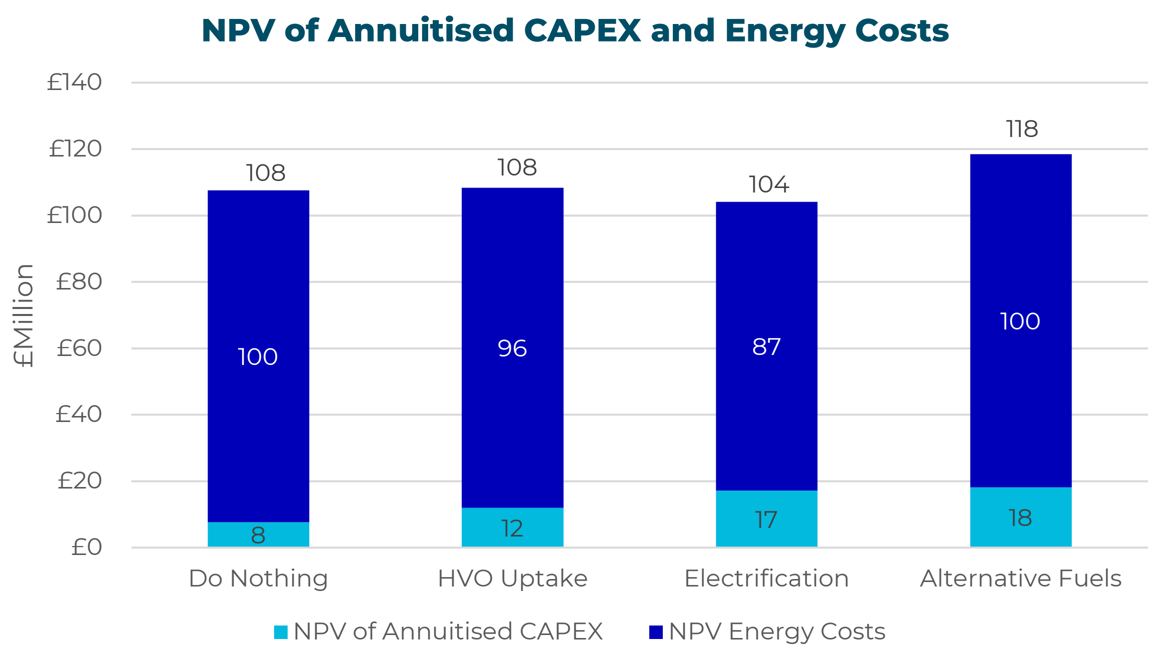


Figure 27 CAPEX and energy costs estimated for the period 2025-2035 under each scenario

Key observations from the investment analysis are as follows:

- The 'alternative fuel' scenario incurs the highest total costs and annuitised CAPEX of all the scenarios. This is due to the current high costs associated with hydrogen-fuelled NRMM and HGVs which are less mature and more costly technologies compared to the conventional or battery counterparts.
- The 'electrification' scenario is interestingly the scenario requiring the lowest level of total investment throughout the period (CAPEX and energy costs).

From the figure, we can observe that the annuitised CAPEX over the period is higher than the 'HVO uptake' scenario but not as high as the 'alternative fuel' scenario since the costs of such technology, such as electric NRMM and HGVs, is somewhere in between the conventional technology and that running on hydrogen, which reflects the maturity and likely eventual prices. However, we can see that even though the annuitised CAPEX may be somewhere in between the 'alternative fuels' and 'HVO uptake' scenario, that is offset by the lower energy costs, which are the lowest out of all scenarios. This is as a result of the increased electrification and self-consumption in this scenario, which results in reducing the costs of "fuel". While the costs of bought-in electricity, diesel, HVO and the alternative fuels is uncertain and could significantly vary, self-consuming renewable electricity increases certainty in energy costs.

- The 'do nothing' scenario presents high energy costs, highlighting the urgency with which action must be taken to decarbonise and progress this plan into deployment. Even though to 'do nothing' requires the lowest annuitised CAPEX, it has the highest energy costs due to the increased diesel consumption, whilst limited savings due to lower electricity self-consumption compared to the other scenarios.
- The 'HVO uptake' scenario is the pathway incurring the third-largest costs over the period between 2025 and 2035 after the 'do nothing' scenario. Even though it requires the lowest annuitised CAPEX investment compared to 'alternative fuels' and 'electrification', it has high energy costs, predominantly from the cost of HVO.

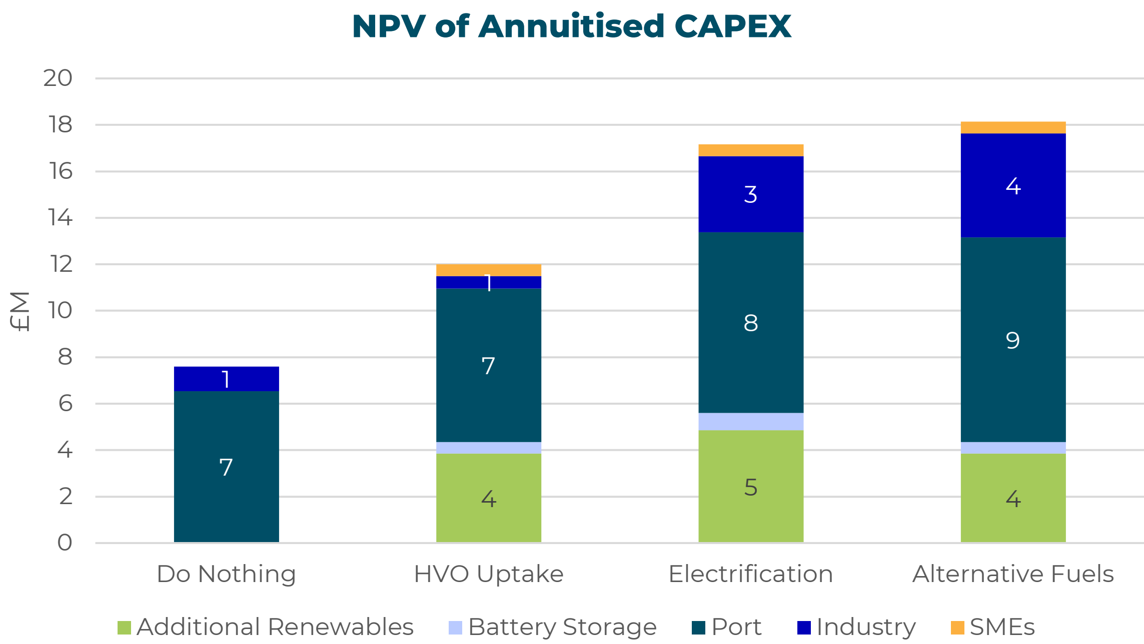


Figure 28 Net Present value of annuitised CAPEX between 2025-2035 by source

To better understand these costs and isolate where the majority of CAPEX is required, Figure 28 breaks down the total annuitised CAPEX over the forecast by source, highlighting the following:

- Renewable and storage make up between 24-36% of the total annuitised CAPEX for scenarios that deploy more renewables (i.e. all besides ‘do nothing’), contributing to a larger share in the ‘HVO uptake’ scenario and a smaller share in the ‘alternative fuels’ scenario. Since the benefits of the renewables and storage are shared across the Cluster, there exists notable opportunity for investment and collaboration with existing renewables partners.
- Leasing of NRMM and HGVs, whose costs are shown as annuitised CAPEX in the analysis, provide valuable opportunity for integrating new technologies. However, the arrangement would mean that the Port would continue to have large annuitised CAPEX. This CAPEX is amplified to reflect the growth in HGVs, which is estimated to double in the next 10 years for 'HVO uptake', 'electrification' and 'alternative fuels'
- The ‘do nothing’ scenario has the lowest annuitised CAPEX figures out of all scenarios but still amounts to almost £8M of annuitised CAPEX across the 10-year forecast due to the continuous costs associated with leasing of HGVs and forklifts.
- The annuitised CAPEX increases from left to right in the figure (‘HVO uptake’ to ‘alternative fuels’) due to the readiness and maturity of technology introduced across scenarios. Electric equipment such as electric HGVs and NRMM are more expensive than the conventional, and hydrogen technology is even more expensive.

Though CAPEX inevitably presents the biggest challenge, when contrasted against the 'do nothing' scenario, the net costs and benefits of electrification do highlight electrification to be once again, the optimal strategy.

The results of the analysis are shown in Figure 29. The figure shows the net present value of the net benefits, where positive values reflect additional benefits, and negative values reflecting additional costs relative to do the ‘do nothing’ scenario. Two additional lines show the net benefits with and without the consideration of carbon costs.

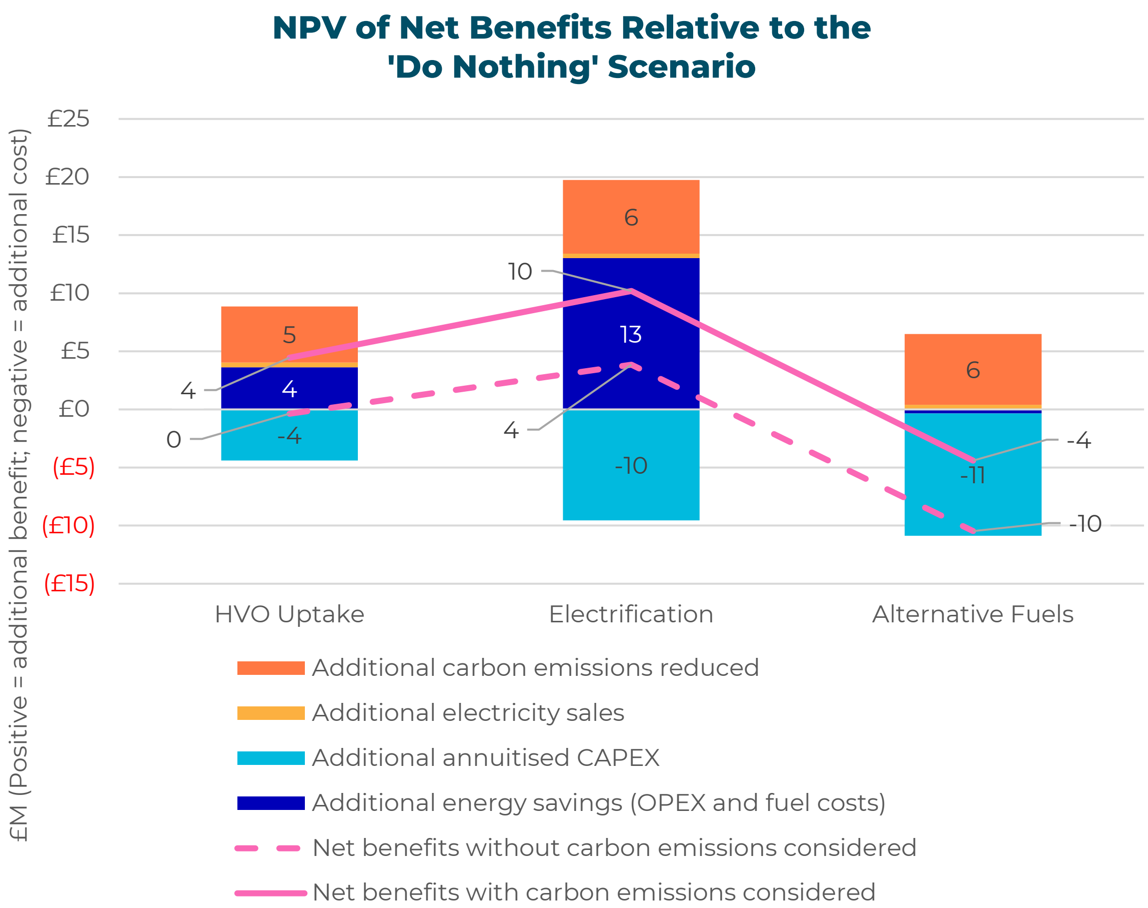


Figure 29 Net present value of net benefits for all scenarios relative to the 'do nothing' scenario

From the figure above, we can observe the following:

- All of the scenarios have additional CAPEX relative to the 'do nothing' scenario, with 'alternative fuel' and 'electrification' scenarios showing the highest additional CAPEX as also reflected in Figure 28.
- The 'electrification' scenario leads to the highest benefits when it comes to emission reduction, followed by the 'alternative fuel' scenario, which aligns with observations presented in section seven.
- Two out of the three scenarios show a net benefit in energy costs relative to the 'do nothing' scenario ranging from £4-13M. The benefit observed throughout is associated with increased self-consumption which is seen across all scenarios from increased renewable and storage deployment and from the energy management assumptions, resulting in cost savings. This is amplified in the 'electrification' scenario which experiences further energy efficiencies from electrification and increased self-consumption to meet energy demand.
- All scenarios also have a small net benefit from electricity sales due to increased renewable energy capacity. However, the net benefit associated with sales is a very small portion of the other relative benefits as it only accounts for around £369k in the 'electrification' scenario and £413k for the other two. Whilst the model considers limited arbitrage benefits from the batteries, it should be

noted that batteries of this scale have the possibility to generate a larger income from various grid services.

- Due to the high CAPEX required for the 'alternative fuels' scenario, the net benefit of the scenario, relative to 'do nothing' is -£10M without considering carbon emissions, initially marking the scenario difficult to justify from purely a financial perspective. When considering the benefits from emission reduction, the NPV does become less negative.
- Without the consideration of carbon emissions, we observe that 'electrification' is the only scenario with a positive NPV (relative to 'do nothing), deeming it the most attractive, whilst the 'HVO uptake' scenario has a neutral NPV. When considering carbon emissions, both the 'electrification' and 'HVO uptake' scenarios look attractive from an economic perspective, with the 'electrification' scenario at almost £10M and the 'HVO uptake' at almost £4M.

As the 'electrification' scenario has the highest net benefit due to the high benefits in energy costs, it is the most effective option for the Cluster at present. Furthermore, even if the carbon emission benefit is removed from the analysis, the 'electrification' scenario continues to present the most attractive option, with the electrification of operations and further deployment of renewables of value in all other scenarios explored.

However, since the benefits are predominantly due to energy costs, this scenario, like the others, and the result, could vary depending on how fuel, electricity, and technology costs evolve, which could reduce or magnify the benefit. Additionally, much of the investment is on renewables and batteries, which have shared benefits, and would likely require some form of collaboration, which likely would also include significant grid modification. Despite the benefits of acting as a joined-up Cluster, this scenario is likely to be challenging to arrange and coordinate.

We estimate the 'electrification' pathway could require a net present value of annuitized CAPEX and energy costs amounting to around £104M from 2025-2035 for the Cluster. Out of this £104M, around 84% would be associated with energy costs, whilst around 20% would be from annuitized CAPEX. More specifically with CAPEX, we estimate the Cluster would need to spend around £27M by 2030 and an additional £25M between 2025-2035 under this scenario (not annuitized). Annuitized, we estimate this would equate to around £7M by 2030 and £18M between 2030 and 2035.

8.3 A Landscape in which we can Decarbonise

Having assessed a variety of technologies and scenarios to develop a primary decarbonisation pathway for the Shoreham Port Industrial Cluster, it is evident the Cluster has the potential to play a key role within the green future of the region. In order to implement the change our region and industry needs and to progress from a plan to deployment, the conditions, polices and landscape in which this can be achieved must be created. Therefore, we call on the Government, innovators and investors, recognising the role we must also play, and put forward the following recommendations to facilitate the ongoing industrial decarbonisation of the Cluster, driving change in our region.

8.3.1 Collaboration & Stakeholder Engagement

Collaboration with industry, Government & other Clusters

Amongst thirteen winners of the Local Industrial Decarbonisation Plan competition, building on the progress already made by six larger industrial Clusters as mentioned in section three, we recognise the role knowledge sharing and collaboration has in the further development and implementation of decarbonisation plans. Though each Cluster varies in location, composition and technological pursuit, the majority face similar barriers, operating in the same policy landscape. By collaborating, we can combine our voices, sharing key information and helping to guide decision making.

Stakeholder Engagement

A values driven Trust Port, transparency and communication with our stakeholders is essential to our success. As we move towards implementation, communication remains absolutely key in hearing the voices from the communities we serve. With new technologies and alternative power sources come new visual impacts and safety concerns. Though our proximity to residential dwellings brings understandable interest and concern, the green technologies we seek to implement will have a direct impact on the air quality of our surroundings, a prospect for which there exists much enthusiasm within our communities. By demonstrating the benefits to air quality, noise and traffic flow from decarbonising Cluster activity, we believe this plan has the potential to mitigate any local concerns around increased renewable energy generation.

8.3.2 Policy & Governance

Throughout the project, Ricardo PLC have utilised their extensive knowledge and understanding of policy, regulation and markets, helping to develop a plan which remains ambitious, yet cognisant of the challenges our country faces in seeking to decarbonise. This extensive insight combined with our own expertise and experience highlights the critical role of policy and Government in creating a social, economic, technological and political environment in which industrial decarbonisation can take place. With any efforts to decarbonise at scale via electrical power source facing extensive delays in achieving grid connections and upgrades, we call upon the Government to ensure that network operators get renewable, clean power and storage projects connected to the grid faster, reforming a laborious and outdated grid connections process.

We remain ready to enact our decarbonisation pathway and call upon the Government to support and create a policy environment in which the investment in and implementation of the required technologies identified within this plan can be made possible.

8.3.3 Research, Innovation & Technological Development

Within our region there exists extensive knowledge and collaboration in the fields of sustainability, decarbonisation and the technologies our communities and industries wish to implement in pursuit of a greener future. Collaborating via projects, working groups and partnerships, immense progress has been made in understanding what must happen to facilitate change.

The last few years have seen great progress in the rate of technological development of future fuels and alternative energy sources, enabling uptake to begin for those businesses able to finance these and tolerate the level of risk which exists when implementing novel and developing technologies. However, for the majority of businesses there exists extensive risk and financial barriers prohibiting this transition, with unproven technologies constituting an intolerable risk for many. With uptake and development making for a 'chicken and egg' situation, we call upon government to further support and incentivise the implementation of technologies enabling the decarbonisation of vehicles, equipment and associated infrastructure. The Shoreham Port Industrial Cluster stands ready as a willing location to pilot new innovations and approaches.

8.3.4 Legal Planning & Permitting

Our transition to net zero requires the implementation of new and continually evolving technologies, within a site which remains largely publicly accessible and situated within close proximity of residential dwellings. Support within Government, filtering down to respective planning authorities will have a profound difference in the planning and permitting process required to pursue and implement our route to net zero. Without this support and guidance, decarbonisation will not be possible for industry.

We remain familiar with many of the processes and communication avenues required in planning and consenting, having navigated them in the conceptual and feasibility stages of previous projects, as well as further exploration under the Shoreham Port Industrial Cluster plan development.

Conclusions

9 Conclusions

Collaborating with industry, academia, local councils and leading technical experts to form the Shoreham Port Industrial Cluster, this plan is the result of a yearlong collaborative effort, resulting in an ambitious and informed plan for decarbonisation. The research and analysis undertaken has understood energy demand and emissions across a dynamic 110-acre estate, in parallel with the Cluster's economic and social impact, engaging over 200 business and individual stakeholders to understand the challenges and opportunities faced in implementing a sustainable, net zero future.

Undertaking extensive modelling and analysis to assess the feasibility, financial and technical implications of several decarbonisation pathways and technologies, the project has made clear that to 'do nothing' will result in continually high energy demand and associated emissions, posing both substantial financial and environmental cost. Identifying an optimum route for decarbonisation, a series of innovative projects and investments have now been outlined, with collaboration, energy sharing and increased renewable generation critical in delivering this change.

Unlocking Industrial Decarbonisation

Developed within the context of a fluid social, economic and technological landscape, the continued integration of HVO within the Cluster remains a vital means of enabling decarbonisation now, with efforts to encourage this across the region, decreasing emissions and increasing regional fuel security via supply chains. Continuing with other innovations already implemented within the Cluster, there exists scope to expand use of surplus heat in a similar process to the marine source heat pump system, which is already serving SME commercial units.

A substantial natural asset for the region, the continual harnessing of wind energy and expansion of renewable assets presents a crucial means of increasing energy security and reducing dependence on the grid at a time when demand is rapidly increasing. With two 100kW turbines already in place within the Cluster, capable of generating up to 500MWh a year, the opportunity to expand onshore wind generation, following several years of scoping and stakeholder engagement, remains clear. Whilst the direct use case for the increased power is not yet clearly defined the research reinforces that demand for electricity is going to escalate rapidly within the Cluster.

With over 11,000 solar panels already in place across the Cluster, the ability to develop further self-sufficiency presents substantial opportunities, with the project identifying scope for an additional 4.8MW of solar PV on land and buildings. The canal located centrally within the Cluster represents further opportunity, with floating solar a potential means of expanding renewable generation, 500kW is currently being explored.

Where generation does not correlate with consumption, modelling has identified critical value in battery storage, facilitating the storage of excess generation of renewables at times of low demand, enabling use at times of high demand and low generation. Enabling the Cluster to make optimum use of on-site renewable assets and decrease reliance on electricity imports from the grid, at a time when demand is beginning to outstrip supply, a battery energy storage system (BESS) and modifications to the Port electricity grid would enable sharing of renewable electricity across the Cluster. Having shown industrial organisations within the Cluster to be the largest consumer of generation modelled, a further study to assess load flow will provide a vital assessment on infrastructure upgrades.

In addition, though modelling has accounted for some electricity to be sold back to the grid, under the conditions modelled, there remains potential for electricity loss, reaching around 21% of renewable generation, or 6.2GWh, by 2035. This loss highlights clear potential to explore different uses of that electricity across the estate including for local hydrogen production or similar alternatives, maximising benefits from newly developed assets.

As one of the Cluster's most significant sources of emissions, the decarbonisation of HGV and NRMM activity presents further substantial opportunity. Facilitating the large-scale electrification of industrial activity within the Cluster, further detailed analysis on the charging of electrified NRMM and HGVs is required to understand and develop a robust charging strategy, assessing also appropriate locations for charging stations and tether points, respective of operations and energy supply. Though electrification presents the optimal route at present, respective of cost and rate of technological development, many of the studies required to progress this pathway would likewise be required under other scenarios such as hydrogen development.

Furthermore, though targeting energy use within the Cluster's direct control, the provision of large-scale charging infrastructure and continued efforts to assess the feasibility of hydrogen generation and application, may seek to influence emissions outside the Cluster boundary, acting as a catalyst for the regional decarbonisation of industry.

Strategically positioned to play a leading role in the region's net zero journey, the success of this project will require continued collaboration to extract maximum benefit from the projects learning and deployment. Working with the Cluster's neighbours and stakeholders, continued community engagement provides crucial opportunity to demonstrate steps taken, ensure societal benefits are understood and unite in the desire for change.

A crucial hub for trade and employment, supporting over 1600 direct jobs, the Shoreham Port Industrial Cluster can build on the long history and strengths of a Trust Port as it evolves into a zero-carbon centre for trade, employment, and inclusive community engagement.

With thanks to Shoreham Port Industrial Cluster Partners:

ADC ADUR DISTRICT COUNCIL

BARRETT STEEL SHOREHAM

Brighton & Hove City Council

CEMEX

LOCAL FUELS

RICARDO

shoreham port

US UNIVERSITY OF SUSSEX

shoreham-port.co.uk/sustainability

sustainability@shoreham-port.co.uk

Shoreham Port **Industrial Cluster**

Funded by UK Government

UKRI Innovate UK

References

Brighton & Hove City Council. (2024). Brighton & Hove Decarbonisation Pathways. Retrieved from https://www.brighton-hove.gov.uk/net-zero/brighton-hove-decarbonisation-pathways-report

British Ports Association. (n/d). What are Trust Ports? – A British Ports Association Briefing Paper https://www.britishports.org.uk/content/uploads/2023/08/What-are-Trust-Ports-A-BPA-Briefing-Paper.pdf

Centre for Economics and Business Research. (2022). The economic contribution of the UK Ports industry. Retrieved from https://www.maritimeuk.org/documents/1138/2022_CEBR_Report_Ports_industry.pdf

Climate Change Committee. (2023). Progress in reducing emissions, 2023 Report to Parliament. Retrieved from https://www.theccc.org.uk/wp-content/uploads/2023/06/Progress-in-reducing-UK-emissions-2023-Report-to-Parliament-1.pdf

Department for Energy Security and Net Zero. (2023). Local Industrial Decarbonisation Plans competition: winning projects. Retrieved from https://www.gov.uk/government/publications/local-industrial-decarbonisation-plans-competition

Department for Transport. (2019). Maritime 2050: Navigating The Future. Retrieved from https:// www.gov.uk/government/publications/maritime-2050-navigating-the-future -

Department for Transport. (2021). UK Port Freight Statistics: 2020. Retrieved from https://www.gov.uk/government/statistics/port-freight-annual-statistics-2020

European Parliament. (2023). Climate change: the greenhouse gases causing global warming. Retrieved from https://www.europarl.europa.eu/topics/en/article/20230316STO77629/climate-change-the-greenhouse-gases-causing-global-warming

Government Social Research profession. (2022). A guide to inclusive social research practices. Retrieved from https://www.gov.uk/government/publications/a-guide-to-inclusive-social-research-practices/a-guide-to-inclusive-social-research-practices

The Intergovernmental Panel on Climate Change [IPCC], 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

HM Treasury, (2006), 'Stern Review: The Economics of Climate Change. Retrieved from http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf

International Chamber of Shipping. (2020). ICS report reveals scale of challenge to decarbonise shipping. Retrieved fromhttps://www.ics-shipping.org/press-release/ics-report-reveals-scale-of-challenge-to-decarbonise-shipping/

Marine Maritime Organisation. (2024). UK sea fisheries annual statistics. Retrieved from https://www.gov.uk/government/collections/uk-sea-fisheries-annual-statistics

Martin, Polly. (2024). 'We will not invest in any more clean hydrogen projects until we secure more offtake for our existing ones': Air Products. Retrieved from https://www.hydrogeninsight.com/production/we-will-not-invest-in-any-more-clean-hydrogen-projects-until-we-secure-more-offtake-for-our-existing-ones-air-products/2-1-1737152?zephr_sso_ott=Pd2XIP

National Energy System Operator. (2023). FES Documents. Retrieved from https://www.neso.energy/publications/future-energy-scenarios-fes/fes-documents

Palladino, Camilla. (2024). Lex in depth: how the hydrogen hype fizzled out. Retrieved from https://www.ft.com/content/14a60649-172a-45c1-99a9-039f481430e7

Pike, K., Butt, N., Johnson, D., Walmsley, S. (2011). Global Sustainable Shipping Initiatives: Audit and Overview 2011 A Report For WWF. Retrieved from https://awsassets.panda.org/downloads/sustainable_shipping_initiatives_report_1.pdf

Ritchie, H., Roser, M. (2020). CO_2 and Greenhouse Gas Emissions. Retrieved from https://ourworldindata.org/ co2-and-other-greenhouse-gas-emissions#note-1

UK Department for Energy Security & Net Zero, Energy and Emissions Projections 2023, EEP – Annex M – Growth assumptions and prices: https://www.gov.uk/government/collections/energy-and-emissions-projections

UKRI (2023). Enabling Net Zero: A Plan for UK Industrial Cluster Decarbonisation. https://www.ukri.org/wp-content/uploads/2023/11/UKRI-141123-EnablingNetZeroPlanUKIndustrialClusterDecarbonisation.pdf

United Nations. (n/d). Goal 13: Take urgent action to combat climate change and its impacts. Retrieved from https://www.un.org/sustainabledevelopment/climate-change/#:~:text=The%20historic%20Paris%20Agreement%20provides,further%20to%201.5%20degrees%20Celsius.

West Sussex County Council. (2023). West Sussex Economy Snapshot. Retrieved from https://www.westsussex.gov.uk/media/19634/ws_economy_snapshot_sept_23.pdf

Xiao, Guangnian & Wang, Yiqun & Wu, Ruijing & Li, Jinpei & Cai, Zhaoyun. (2024). Sustainable Maritime Transport: A Review of Intelligent Shipping Technology and Green Port Construction Applications. Journal of Marine Science and Engineering. 12. 1728. 10.3390/jmse12101728.

Glossary

Collaboration remains at the core of this project, working with the communities and stakeholders we serve to understand our impacts, ideas and opinions and to pursue a shared green future. Remaining transparent and accountable for our ambitions, this plan is intended to be read and understood by anyone with an interest in the Shoreham Port Industrial Cluster and its future. Where technical terms and acronyms have been used, we have provided definitions below.

Term	Definition
CAGR (Compound annual growth rate)	CAGR represents the average annual growth rate. It smooths annual rates over time by averaging the growth rate over the period, even when the rate varies from year to year. The formula to calculate CAGR is: $CAGR = \frac{Ending\ Value}{Beginning\ Value}^{\frac{1}{Number\ of\ years}} - 1$
Carbon Emissions	The release of carbon dioxide into the atmosphere, primarily from burning fossil fuels, industrial processes, and deforestation.
Circular Economy	An economic model aimed at minimising waste and making the most of resources by reusing, recycling, and regenerating products and materials.
Greenhouse Gases (GHGs)	Gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) trap heat in the Earth's atmosphere, leading to global warming and climate change.
HGV (Heavy Goods Vehicle)	Large trucks used for transporting goods, often targeted for electrification or fuel replacement to reduce emissions.
HVO (Hydrotreated Vegetable Oil)	Renewable diesel alternatives produced from vegetable oils, waste fats, and greases. It provides significant reductions in CO_2 emissions compared to fossil diesel (>80%).
Marine Gas Oil (MGO)	A type of diesel fuel used in ships.
Marine Source Heat Pump (MSHP)	A system that uses heat from seawater to provide heating and cooling for buildings, reducing reliance on fossil fuels.
Net Zero	Achieving a balance between the greenhouse gases emitted into the atmosphere and those removed from it, typically by 2050 as set by international agreements like the Paris Agreement.

Non-Road Mobile Machinery (NRMM)	Equipment like cranes and forklifts used in industrial or construction settings.
Scope 1 Emissions	Emissions released from direct sources that an organisation owns or controls such as fuel.
Scope 2 Emissions	Indirect emissions from the purchase and use of electricity, steam or heating and cooling
Scope 3 Emissions	All other indirect emissions from the value chain of a company.
Sustainable Linked Loan (SLL)	A financing mechanism that incentivises borrowers to achieve sustainability targets, such as emission reductions.
Trust Port	A port governed by a board of trustees that operates for the benefit of stakeholders and reinvests profits back into its facilities and community.

Appendices

Table 1. UK Grid electricity emission projections from 2023 to 2035 (National Energy System Operator [NESO], 2023).

Factor	Units	2023	2025	2030	2035
Grid Electricity carbon intensity	kg CO_2e/kWh	0.207	0.127	0.071	0.022

Table 2. Emission factor for different fuels used in the system

Fuel	Unit	Emission Factor
Natural gas	kg CO_2e/kWh	0.203
Shell GTL Fuel	kg CO_2e/L	2.510
HVO1	kg CO_2e/L	0.036
Marine A2 Gas oil	kg CO_2e/L	2.771
Marine GTL	kg CO_2e/L	2.510
Petrol	kg CO_2e/L	2.345
Diesel	kg CO_2e/L	2.662
Hydrogen	kg CO_2e/kg	2.400
Methanol	kg CO_2e/L	0.440

Table 3. Net calorific value of different fuels used in the system

Fuels	Unit	Net Calorific Value
Natural gas	kWh/kg	12.650
Shell GTL Fuel	kWh/L	9.500
HVO	kWh/L	9.533
Marine A2 Gas oil	kWh/L	9.962
Marine GTL	kWh/L	9.500
Petrol	kWh/L	9.217
Diesel	kWh/L	9.921
Hydrogen	kWh/kg	33.330
Methanol	kWh/L	4.330

[1] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024

Table 4. Carbon pricing assumed to estimate net benefits (UK Department for Energy Security & Net Zero, 2023)

Unit	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
£2024/tCO_2	89.91	103.56	110.39	111.53	101.29	99.01	106.97	113.81	121.77	126.33	137.71

Table 5. Efficiencies assumed for different technologies

Unit	Diesel engine efficiency	Electric drive train efficiency	Hydrogen fuel cell efficiency	Hydrogen dual -fuel diesel savings	Methanol engine efficiency
Efficiency (%)	33%	90%	60%	50%	33%