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# LOOP PORTS

## Circular case studies

*Summary report of the analysed case studies*

*LOOP-Ports project*
*https://www.loop-ports.eu/contact/*

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# A circular economy network of ports

The main goal of the LOOP-Ports project is to facilitate the transition to a more circular economy in the port sector, where products, materials and resources are maintained in the economy for as long as possible, and the waste generation minimized.

## The LOOP Ports Project

The purpose of the project is to map, understand and assist in the transition to a circular economy, within ports. Emphasis is put on a series of high-emitting materials; metals, plastics, cement and bio-materials, but the project is open to expanding to other streams of waste.

*"LOOP-Ports aims to facilitate the transition to a more circular economy in ports through the creation of a Circular Economy Network in Ports that will provide an innovation ecosystem around the port activity and stimulate circular economy initiatives in ports."*

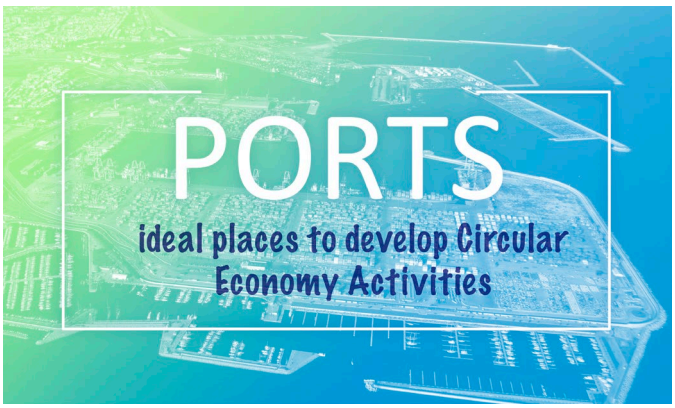
## Why ports and circularity?

Ports are considered a key gateway between countries, and they are vital in the strategic planning of intermodal transport in Europe. In addition, most ports are hosts to a wide array of industries, making them a beacon for both the creation and the transport of waste in different streams.
This makes them increasingly interesting in a circular scope, as the economies of scale can create a massive impact if circular principles are implemented successfully.

LOOP Ports is aimed at aiding the transition towards circular ports. This is to be driven through the network of ports, that together share and drive ambitious circular efforts.

## Available tools and resources

The project partners have created a full mapping of all EU ports, including statistics, environmental, overall features and the identification of circular economy activities performed or planned in all EU ports.
The results are published online, along with a report of circular practices, if you are interested in these results, please visit: www.loop-ports.eu




## Future of the project

The project is driven as an innovation ecosystem, between the LOOP Ports partners, and their network of ports and port stakeholders. The objective is to establish a stable working group that play the role of advisor in circular economy applied to ports. All the collected results by the project can serve as a keystone for those entities, ports, etc. that can improve their strategy in circular economy.
All port stakeholders are welcome to join the network and transition.

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# 6 types of circular actions

To ensure a structured approach to the circular economy transition, several tools have been developed. The below rendition of different actions towards circularity can be addressed on both private company and state level. They are based on the waste hierarchy and constitute an overview for the cases which will be addressed.

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## Rethink

Making a difference, on a larger scale, requires conscious thought and reflection on what we are doing, and how we are doing it. Circular economy can be applied during designing, producing, consuming and disposing. Potential lies in sharing and having access to products without owning them, by designing them so that they can be repaired and maintained. Waste should no longer be the end of our consumption, but the start.

## Reduce

The simple notion of this action is to consume less. Not to consume less than what you need, but to not overconsume and to consume products that reduce waste per item, such as refillables.

## Reuse

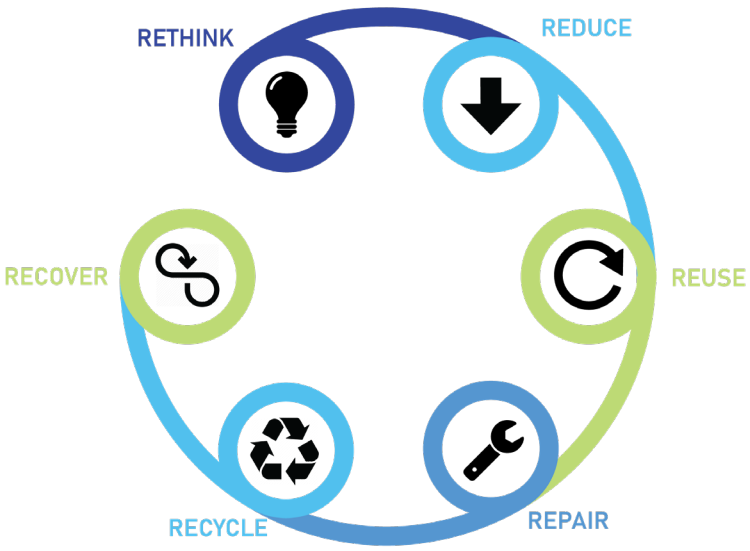
Reuse of products can be done in many ways. It ties with reduction of single-use items from Reduce. Simultaneously, passing on items to other users once you are done using them, is an effective way of reusing them.

## Repair

Repair is perhaps the simplest of the concepts. Extending the life of an existing product instead of discarding it, makes sure that the product is used to its full potential.

## Recycle

Recycling can be done at all levels, and is, if targeted correctly, a highly valuable addition to consumption in households and companies alike. Several materials are, when recycled, able to be reused with the same properties they originally had, while others can be used for new purposes.




## Recover

Recover embedded energy from non-recyclable waste material where feasible. Non-recyclable waste may at least be converted into energy through waste-to-energy processes such as combustion and gasification. Energy recovery may also be the capture and reuse of released heat from air and water systems. Energy recovery is a preferable waste handling process. However, recovery not always refers to energy. In some cases, the process can create a wide range of high-value products.

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## Aalborg Portland, Denmark

# Circular sourcing for cement production

## Aalborg Portland carries out dredging on behalf of the municipality – in return the cement company get access to sand for their cement production

**The production of cement takes massive tolls on the environment, using both large amounts of materials and energy. Aalborg Portland have found a way to expand production, using alternative materials and waste-to-energy to eliminate the high climate impacts. This is obtained through strategic partnerships with local stakeholders, designing systems that utilize what was previously considered waste, as production inputs.**

### Location of the case

One of the most important companies located in the near-port area of port of Aalborg is Aalborg Portland, which manage their own privately-owned ports under Aalborg Port Authority. The port of Aalborg is located in the northern part of Denmark, on the Jutland peninsula. The port is primarily accessed from the Baltic Sea to the east, which requires navigation through about 30 km of relatively narrow channels in Limfjorden from Hals Barre to Aalborg.
Around 100 companies reside in the near-port area of Port of Aalborg, ranging from transport, logistics and freight companies to more traditional sales companies who utilize the possibility of being located closely to the multiple freight options the port offers.

### Role of the port

Aalborg Portland owns and operates its own private port, as part of the Port of Aalborg. From here, the company ships its material, virgin, secondary and final products, in and out of the city. The port is vital to the operation, as both the cement itself, and the production inputs needed have a high volume and weight, making most other modes of transport unfeasible.

### Dredging is a necessity

The operation of dredging is essential in most ports around the world, to ensure adequate depth in key navigation channels. The port of Aalborg is no exception. While the navigation channel itself is kept clear due to the current, the access point by Hals Barre would regularly get covered in sand, if dredging was not carried out. Keeping this channel accessible is vital to the port of Aalborg, which was previously one of the primary industrial drivers of the city.

### Using the dredging materials

The dredged material is often discarded at sea at designated dump sites, however recently companies and ports alike are starting to utilize the materials in new and innovative ways. At Aalborg Portland, the use of dredging sand is nothing novel. For over 30 years the port has kept the channel dredged to a minimum of 11 meters. The materials are used in their cement production, substituting virgin sand that would otherwise be dug out in large quarries, and avoiding trucks moving sand from quarries to the factory which means less carbon emissions.

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# Aalborg Portland, Denmark

## From dredging to cement

The production of cement relies primarily on two material streams; chalk and sand. The chalk is dug out right behind the production facilities of Aalborg Portland, east of the city of Aalborg. Meanwhile, the sand comes primarily from the dredging operations, totalling to more than 93,000 tonnes of sand each year.

The sand is dredged continuously throughout the year and is subsequently pumped directly from ship into 3 holding basins. Each basin is roughly 120x60m, and the sand can be stored at a height of up to 10m. The sand is stored for 3-4 months in each basin, going through a process of desalination, that is carried out by rainwater. Due to the pure nature of the sand, no further processing is required, and the sand is taken directly from the basins into the cement production, where it is mixed with chalk in large slurry tanks, before going through large ovens and getting turned into different types of cement.

## Circularity is good for business

Having sourced their sand from dredging for over 30 years, Aalborg Portland is well aware that circularity is not just a trend, it is good business. Therefore, they are continuously sourcing new materials from waste streams found at other companies, effectively targeting both reduction and recycling.

"In 2017 the secondary materials used totaled to 467,000 tonnes, a number which is expected to rise significantly", according to Category Manager Carsten Johansen from Aalborg Portland.

Meanwhile, exploration of the usage of new secondary materials is high on the agenda for the cement producer, reducing its dependency on virgin fossil materials, to ensure a sustainable production. In this way, they rethink their supply chains to increase circularity in the years to come.

## Additional efforts to increase circularity

In addition to the sand dredging operations, Aalborg Portland is involved in a wide range of symbiotic initiatives, using not only secondary materials in their production, but also supplying their excess heat for municipal district heating. Just recently, an ambitious effort to use the massive chalk quarry for remote cooling of the new large university hospital was launched.

In addition, the high-energy demand of the factory (roughly 1% of the total energy demand in Denmark) is fulfilled by utilizing a highly specialized waste-to-energy facility, while energy generated from the leftover heat powers around 20,000 households in Aalborg. Generally, a high degree of synergies between the factory and large companies and the municipality have been obtained throughout their 130 years of operation.

The Aalborg Portland Holding Group has a long tradition of socially and environmentally responsible behaviour and is committed to making significant contribution to realising society's climate goals.

## Key findings

- Use of alternative materials and waste-to-energy approach reduces climate impact.
- Regular dredging activities valorize dredged material in cement production.
- Symbiotic relations between Aalborg Portland, companies and the municipality lead to different waste-to-energy initiatives: from cooling local hospital to heating around 20,000 households.


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## Port of Goro and Garibaldi, Italy

# Plastics from aquacultural farms

## In Italy, local stakeholders are developing approaches to ensure a sustainable production of mussels in farms, while avoiding the contamination from plastics

**In the North East of the Adriatic Sea, most of the marine litter found can be traced back to the practice of mussel farming. Nylon, Polyethylene and Polypropylene are all materials with a high potential for recycling, and efforts are being explored to create circular supply chains needed to ensure this approach. Simultaneously, the development of biodegradable nets are being pursued, rethinking the classic design.**

### Location of the case

Located in the North-eastern part of Italy, the maritime compartment of Ravenna stretches across 70 km of shoreline in the Emilia-Romagna region. The region is responsible for the largest aquaculture production across the Italian regions, a sector which has experienced exponential growth since the 1980s.

The ports of Goro and Garibaldi are home to 386 fishing companies, comprising more than 50% of the capacity in the entire region. Simultaneously, the area has a thriving aquaculture sector, with over of 1,300 companies devoted to the breeding of different species of clams, oysters and mussel, on- and off-shore.

### A key industry for the port

The aquaculture industry in the Emilia-Romagna region is responsible for generation of economic value more than € 100 million. As a result, the port and the industry is heavily intertwined.

The port is municipally owned and governed, and the port authority is responsible for developing and maintaining the port area, which is then rented out to the private contractors. Close collaboration between both private and public actors is thus a necessity to ensure a sustainable production in the future.

### Ghost nets and plastic waste

Marine litter is globally acknowledged as a major societal challenge of our time, and most reports agree, that the Mediterranean Sea is one of the worst affected places.

The majority of marine litter is found to be polymer materials, accounting for around 90% of the total.

While it is hard to pinpoint the exact sources of all polymer waste streams that end up in the marine environment, two particular waste streams related to the aquaculture industry come to mind; fishing ghost-nets and mussel-farming nets.

A local study showed, that during a month, around 900 kg of waste accumulated at the beaches of Porto Garibaldi, of which 78% was traced back to the aquaculture industry and 15% from urban mismanaged waste. While the impacts of the industry are all a result of an increase in consumption, the problems created by marine litter can be tackled in many other ways. In the last years, more than 600 tonnes of fishing nets per year have been treated and converted into plastic strings and then sold to secondary plastic producers.

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# Port of Goro and Garibaldi, Italy

## Driving the change in partnerships

To solve this growing issue, the local stakeholders are attacking the problem on two fronts. First, efforts are being made to create circular supply chains, allowing for collection and recycling of existing equipment. Second, new and innovative ways of rethinking the nets are being pursued, creating bio-degradable or sustainably produced nets, to limit the impact of the industry on the environment.

## Creating circular supply chains

Public authorities are responsible for the traditional management and collection of waste in the Emilia-Romagna region, which includes port reception facilities, a role that is undertaken by Clara spa. However to ensure a long-term solution that tackles the issues of ghost-nets, emphasis needs to be on collection at sea.

To solve this problem, direct involvement of the farmers and fishermen is needed in three areas; prevention measures to limit lost nets, reporting of lost nets, and collection and sound disposal of nets found at sea.

The fishermen already show high commitment to collaborate on the collection and landing of marine litter, as long as adequate measures are put in place in the ports, to allow easy and free disposal.

The last piece of the puzzle, was then to involve a producer that can re-use the plastics to produce new polymer granulate from the recovered nets. GE.FE Polymers and RAMAGO do exactly this and have already established a partnership with the organization SAPLA who are coordinating a joint supply-chain initiative to solve the marine litter issues created by ghost nets.

## Designing out waste

While a circular supply chain can solve the immediate issues, a long-term solution requires a deeper rethinking of the industry.

APM and BioPro have started the production of not only biodegradable packaging for the finished mussels for distribution, but also nets and socks for the breeding farms. These nets will, once market uptake is successful, be able to completely remove the need for the circular supply chain for plastic fishing nets in the region.

## The next steps

The potential of establishing a circular supply chain around the aquaculture farming industry is massive. All actors are present, and willing to engage in the necessary steps. In the coming year, close partnerships will be established to ensure a sustainable production and supply chain.

The development of biodegradable nets will hopefully become a success on the long-term, but until then, the circular supply chain will solve the immediate issue faced.

## Key findings

- In the North East of the Adriatic Sea, most of the marine litter is linked to mussel farming.
- An initiative to create circular supply chains was launched that will reduce marine litter by collection and recycling of existing equipment.
- An initiative to develop bio-degradable or sustainably produced nets would provide a long-term solution.


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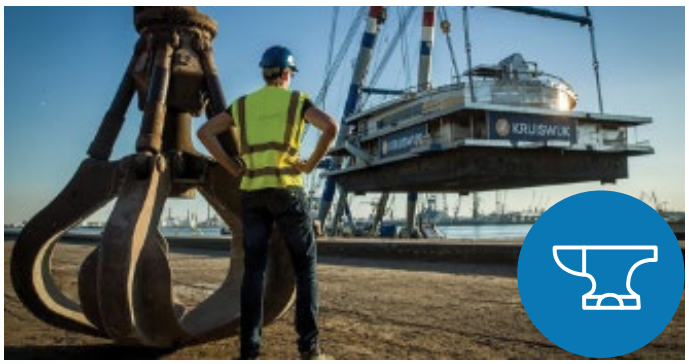
## Port of Frederikshavn, Denmark

# Circular Decommissioning of ships and rigs

## M.A.R.S will, with the establishment of the first purpose-built decommissioning site in Europe, create new circular supply chains with local stakeholders

**The ship decommissioning sector has been tarnished by stories of bad working environments on the beaches in Southeast Asia. With this increasing pressure on the global legislation has been rising. Couple this with a North Sea offshore sector in transition, and you get a rapidly growing decommissioning market in Europe.**
**Enter Modern American Recycling Services, a highly specialized US company, who have their eyes set on circular decommissioning in Europe.**



### Location of the case

The port of Frederikshavn is located in the northern part of the Jutland peninsula. The port is primarily accessed from the Baltic Sea to the east and enjoys shelter from the dominant western winds that reside in Denmark.
The port has, since the closure of the large shipyard, Danyard, in the late 90's, experienced a growing specialization in the offshore industry. Now, the port is home to a wide range of service providers, as well as a new and smaller shipyard, who together provide full-service solutions covering both service, maintenance and retrofit of all types of ships and offshore equipment.

### Role of the port

In 2014 the Port of Frederikshavn made an ambitious 3-stage plan for an expansion of the port to almost twice its original area. In 2019 the first stage was officially inaugurated, while the second stage is already underway.
As a result of the expansion, the port paved the way for attraction of new customers within the offshore segment. One of these customers is the American recycling and decommissioning company MARS. The environment in Frederikshavn provides a great synergy for MARS's European expansion, while the port provides a purpose-built site, ensuring state-of-the-art solutions.

### Ensuring a stable supply of secondary steel

The left-over product, after dismantling of ships and offshore structures, among other metals, is steel. Around 90% of ships, and 80% of offshore structures such as oil and gas rigs are composed of some sort of steel alloys.
While the steel is the most prominent material in terms of quantity, other very valuable components such as machinery will also need to be handled. In addition, non-ferrous metals such as copper, aluminum and zinc are found in valuable quantities.

### Scale and possibilities

The facility in Port of Frederikshavn is projected to be able to produced around 200,000 tonnes of steel each year. This constitutes the biggest turnover of ships/rigs in Northern Europe at present, once the facility starts operations in late 2019.
The first project will be decommissioning of the Tyra East topsides, a contract that was awarded to MARS earlier this year.
The facility is committed to developing and improving its established best practices, and a full circular system is the ambition of MARS Europe in the future.

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# Port of Frederikshavn, Denmark

## Decommissioning - a growing global problem

The problems associated with decommissioning is a result of the growing shipping industry, which again is the result of a globalized industrial world. With the growth, a transition from small to consolidated mega-shipping leaves many ships obsolete each year.

The NGO Shipbreaking Platform collects and publishes a list of ships that are being decommissioned each year. From this resource, it is quite clear that most of ships today, end their life on the beaches of Alang (India), Chittagong (Bangladesh) and Gadani (Pakistan). All of these sites are heavily critiqued for their lack of safety and their harsh working environments.

The International Maritime Organization are trying to pass legislation to improve the standards, the so called Hong Kong Convention. However, for the legislation to enter into force, at least 15 countries constituting 40% of the global industry need to ratify the convention – a goal which has not yet been achieved albeit the convention turning 10 years in 2019.

## Solving global problems at a local level

M.A.R.S. brings highly specialized experience and practices from decommissioning in the Mexican Gulf, however, they are well aware of local ownership and anchorage of their operations.

As a result, the local offshore industry in Port of Frederikshavn is involved in several stages.

A joint-venture has been established between Orskov Yard, VMS Group and Scanel International, to help source offshore rigs for decommissioning, and ensure reuse and retrofit of mechanical and electronic equipment from the rigs.

Meanwhile, local recyclers Stena Recycling, Fortum and Peter Sørig have joined in to take care of smaller more specialized material streams.

## A market on the rise

New EU legislation (The Ship Recycling Regulation No 1257/2013) states that EU-flagged ships need to be decommissioned at approved sites. This approval has already been obtained by the new Danish facility – opening the market for decommissioning of ships. The new facility will be able to handle anything up to the Panamax size.

The first offshore structures in the North Sea have reached their end of life. This first wave of structures will primarily consist of oil and gas rigs, however, the supply of offshore windmills from the first generation of North Sea windfarms will need to be decommissioned as well, ensuring a market that is predicted to last at least 30 years.

## The future of decommissioning

With the decommissioning market on the rise, several large actors are moving into the space. In the UK a branch organization called Decom North Sea has been established, and in Denmark, Mærsk Decom was founded as a unit under the shipping company in 2018.

Making sure that circularity is pursued, should be the top priority in the sector in the year to come. As more actors will be entering the arena, establishing high minimum requirements and industry-wide best practices will be key.

### Key findings

- Decommissioning is associated with harsh working environments mainly taking place in India, Bangladesh and Pakistan.
- New EU legislation provides new business opportunities for rapidly growing decommissioning market in Europe.
- Port's expansion plans provided the space for the new business opportunities to take place in the Port of Frederikshavn


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## Port of Marseille, France

# Capture of greenhouse gases in microalgae

## The VASCO project is using state-of-the-art green chemistry to transform industrial fumes such as CO2 into a production microalgae

**The project captures industrial fumes from large plants and use them to feed a production of microalgae. The algae, when harvested, is then used in the production of biofuels. As a result, the project turns CO2 into sustainable fuel.**
**The Vasco2 project has managed to successfully demonstrate the approach at pre-industrial levels, and through Vasco3, the partners are now targeting a full scale industrial demonstration.**


### Location of the case

The Port of Marseille is located in the southern part of France, and stretchers for more than 70 km on the Mediterranean coast. The port has included two main sites, that in total makes Marseille the largest freight port in France, based on volume. The Eastern Harbour is located at the centre of the city and include some freight, but primarily ferry and cruise terminals. The Western Harbour, also known as Marseille Fos is home to the large freight and container terminals, receiving more than 1.5 million TEU each year. In addition, Marseille Fos is home to a large industrial zone covering 10,000 hectares. This industrial zone is responsible for the direct and indirect creation of more than 25,000 jobs and is thus vital for the region.

### Role of the port

With a large gathering of industrial companies covering both refineries, and the chemical industry, the access to the port area to minimize freight distances and costs is core to the development of the industrial areas.
The Port of Marseille is the main driver behind the Piicto program, developed to encourage innovation and increase the attractiveness of the area by creation of new activities – a program that leads to the Vasco project, among others.

### Untraditional waste streams

The waste generated in industrial areas is usually thought of as tangible goods that can be moved in trucks or containers. However, in all industrial parks, one of the primary waste streams are the amount of greenhouse gases emitted into the atmosphere. This is exactly the target of the Vasco project.
The project is targeted directly at obtaining, processing and using CO2 as a raw material. Through cultivation of algae, which is harvested, concentrated and transformed into biobrust. The biobrust will then be refined until a biofuel is obtained

### Fuel from algae

At the other end of the supply chain, the partners are exploring ways of turning the algae into a range of different biofuels.
So far, the tests show that with a production of 1 hectare of algae pools, the approach is able to use 275t of CO2 to produce 280t of algae paste, that is then turned into different fuel streams. The most environmentally friendly fuel solution is still being tested.

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# Port of Marseille, France

## Broad alliances paving the way

The partners in the Vasco projects comprise a wide range of stakeholders, from different industries, all interested in the development of these types of new circular initiatives.
The technology is developed by Coldep supported by Ifremer and CEA researchers. The key innovation is the ability to dissolute the CO2 into the production of algae.
Meanwhile the energy company Total is responsible for most of the research into the creation of sustainable fuels from the algae, along with the industrial partners.


## Creating a new environmental sector

The concept feasibility has already been confirmed, and the goal is to create a completely new industry, able to generate high-value products from one of the industrial worlds biggest waste problems, CO2.
The partners plan to implement an industrial-scale demonstrator, the last step before a large-scale production of oil substitutes and third-generation biofuel. With the launch of the Vasco3 project, the goal is to scale up production and develop a full R&D centre, as well as scaling up the pools from around 150 m2 to 3,000-5,000 m2 across at least 3 different sites.

## A long term investment

The projects have so far accrued investments of more than € 2 million, half of which has been provided by the industrial partners, while the remaining is financed by ADEME, a French public finance institution.
The project Vasco1 was started back in 2011, and so far, the research has resulted in a Technology Readiness Level of 6, with the conclusion of the Vasco2 project. In the coming years, the partners expect to launch a full scale demonstration, with a goal for industrialisation of the concept by 2025. At this time, a TRL level of 9, and a full market launch is expected to conclude the 15-year long research part of the project.

The consortium for the Vasco2 project included: Marseille Fos, Coldep, Ifremer, CEA, Total HelioPure Technologies, ArcelorMittal, Kem One, Solamat-Merex, Inovertis, Lyondellbasell, and Aix Marseille Provence.

## Key findings

- The Port of Marseille is the largest freight port in France where one of the primary waste streams are GHG emissions
- The Vasco project focuses CO2 valorization by capturing CO2 in algae and turning it into biofuels
- The project engages different stakeholders interested in the development of new industry and addressing world's biggest waste problem, CO2

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## Port of Boulogne-Sur-Mer, France

# Valorisation of fish by-products

## Former waste streams from the fishing industry are being used to manufacture a range of high-value products in the nutrition and beauty industry

**Since the 1970's a highly specialized cluster has been under development in Boulogne, targeting fish processing at all its different levels. From this, a wide range of by-products are produced. There were previously discarded as waste, but with innovative product development, the company COPALIS have managed to create a wide range of high-value products, supplying both the nutrition and cosmetics industries.**

### Location of the case

The port of Boulogne-Sur-Mer is located in Northern France, with direct access to the busy English Channel, and short distances to busy fishing areas in the North Sea, English Channel and Atlantic Ocean.

The port is home to a national competitive cluster of 200 companies within seafood and seafood processing covering all stages of activities including; shellfish, fishmonger-filleting, trading, shrimp cooking, canning, prepared and elaborated dishes, manufacture of frozen products, salting, packaging, and recovery of co-products.

### Role of the port

The port area is made very attractive to the industrial partners, not just due to the strength in numbers but also by the important role of the cluster Aquimer. The port provides massive cold storage spaces, which is a necessity for most of the activities carried out.

All of the companies in the fishing industry are located within the Capecure area. Capercure is the economic and industrial area of the city of Boulogne-Sur-Mer. This provides an ultra-efficient logistics distribution, saving the companies both time and resources.

### An industry with big impacts

The total industry for processing of fish products in Boulogne-Sur-Mer consumes huge amounts of materials. In addition to the raw materials themselves, 380,000 tonnes of fish, the cluster is responsible for consumption of 1.2 million m3 of water, 50Gwh of electricity, 450 GWh of gas, 2,800 tonnes of packaging materials, and 7,000 tonnes of salt.

Former waste streams from the fishing industry are used to manufacture a range of high-value products such as nutrition, and in the well-being and beauty industry. COPALIS Company was created in the 60s' to tackle this amount of fish waste/resources and create valuable products for some of the port's actors.

### One mans trash is another mans treasure

COPALIS is targeting three primary sectors, for valorization of the fish by-products; Animal nutrition (pet food, milk substitutes, aquacultural breeding agents), Human nutrition (peptides, anti-ageing agents, mood enhancing ingredients, aromatic extracts) cosmetics and dietetics (primarily collagen). The total production, is in the range of 25,000-30,000 tonnes of byproducts, with a split of 90%, 7-8% and 1-2% in the three categories respectively.

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# Port of Boulogne-Sur-Mer, France

## From fish meal to cosmetics

First, fish meal and fish hydrolysates, which are used in fish-based fertilizer and in an animal food, were produced. With the development of new technologies in the late 90's, such as fractionation and peptides isolation, new possibilities for treating fish co-products became available. This allowed Copalis Sea Solution to process the rest of the fish after the fileting step to extend its range with marine bio-actives. As a result, it now produces raw materials and ingredients for the nutraceutics, functional food, cosmetics and animal nutrition markets. Each of these products is a high-quality and high-value material.

## Circular supply chains

The proximity associated with a cluster such as the one I Boulogne, is a key advantage when wanting to create circular supply chains. Not only does it eliminate a wide range of costs, it also ensures the freshness of the by-products.
COPALIS sources all its products directly at their source, having access to hundreds of different suppliers mainly in Boulogne. The main source, is the fileting factories, from which all by-products including trimmings, skin, cartilage and bones can be utilized in different production streams.

## Making it happen

A number of drivers made this circular initiative into what it is today. The competitive advantage obtained through having economies of scale was where it all started. However, a revitalization effort by the municipality in order to maintain the area's competitive position in relation to neighboring ports proved equally important. This made time and knowledge from experts available for the exploration of opportunities.
The collaborative nature inspired a new mindset along with sharing of knowledge, which led to a shift in culture from thinking waste, to thinking resource, ultimately resulting in new innovative technologies.

## Moving forward

In the coming years, COPALIS is targeting an expansion towards the east and the west, having set it sights on US and Asian markets. One thing that still needs to be investigated, is the viability of importing waste from one destination to another, instead of having the local setup and close distribution lines which have proven vital to the French success.

## Key findings

- Former waste streams from the fishing industry are used to manufacture a range of high-value products
- Fish by-products are used in production of animal nutrition, human nutrition and cosmetics
- Co-location of key stakeholders (suppliers of by-products and the processing site) provides additional advantage with lower prices and freshness of the products

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# Involvement of Port Authorities in circular initiatives - illustrative cases

Many activities are aimed at generic waste treatment and management. Other material flows that are subject of recycling activities comprise: metals, construction materials, plastics and biomass and sludge. The use of gases is the main topic for activities identified as industrial symbiosis.

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### Port of Antwerp, Belgium, Carloop project

Many of Europe's used cars are exported through Antwerp to West Africa where they are given a second life. With Carloop, Antwerp Port Authority has set up a pilot project to bring back usable parts and to recycle them. Cars can be recycled up to 97% by reusing their components or exploiting them as a source of raw materials for new products.

### Port of Amsterdam, the Netherlands, Prodock supporting CE startups

The port of Amsterdam has developed Prodock, a site where circular economies that have outgrown their start-up phase can continue developing. Prodock offers the companies in- and outdoor space, office space, as well as a network of other start-ups and investors. An example is the Calcite Factory, which is an initiative of Advanced Minerals and Waternet. Their pilot plant takes calcite out of drinking water for use in the paper and glass industry.

### Port of Marseille, France, Reclaiming dredged material

Dredging is a vital to keep up port activities, but results in large volumes of waste material. The creation of the MuCEM harbor basin and the maintenance of the Arles canal generated a total of 150,000 m3 of dredge waste. Rather than disposing it in the already overstretched tips, the material was used to prepare the land for the building of the Distriport platform. This avoided the use of new mineral resources and eliminated the transport of the material to the tips.

### Zeeland Seaports, The Netherlands, Industrial symbiosis between port and surrounding sectors

The project WarmCO2 led to the construction of hot water and CO2 transport pipelines, between Yara and the greenhouse horticulture area in the neighbouring hinterland. In the horticultural area, the residual heat and residual CO2 from Yara are used to heat the greenhouses and allow the plants to grow faster.

### Port of Haminakotka, Finland, Digital Seaport

The Port of HaminaKotka will introduce a comprehensive 3D operating system developed by VRT Finland to intensify the daily operations of the entire port, which enables the efficient saving, comparison, sharing and intelligent utilization of materials in the everyday operations and maintenance of the port.

### Port of Dover, UK, Refurbishment of three berths

The British ferry port of Dover is Europe's busiest ferry port, with about 13 million passengers in cars, trucks, coaches, etc. crossing the Channel to and from the mainland each year. The Port authority decided to refurbish and actually fully renovate 3 old berths. The work consisted of the disassembly, repairs, blasting, preservation and, if necessary, replacement of the ro/ro system.

### Port of Ramsgate, (UK) Buoy maintenance by modular design

The port authority of Ramsgate replaced several buoys by new navigation buoys using more dureable materials in a modular way. The modular design allows for commonality of parts, therefore reducing maintenance, inspection, replacement and spares holding costs.

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# Circular ports activities in Australia, US and Asia

## Port Kembla, Australia

As a part of works on Berth 103 at Port Kembla, 120,000m3 of dredged material was collected and deposited within the footprint of the approved Port Kembla Outer Harbour Development. Port Kembla Steelworks (BlueScope company) imports raw materials (iron ore, cokes) for steel production by ship. A key part of BlueScope's manufacturing processes is to minimise the use of resources, reducing the amount of waste material produced and re-using or converting waste materials into other valuable products.

## Zhuhai Gaolan Port (GUANGDONG), Asia

The port promotes circular economy through industrial symbiosis. The Chinese authorities aim for setting up industrial symbiosis parks. The cooperation is not restricted to re-use of waste streams, but also covers actively seeking industrial partiers that reinforce the output and productivity of an industrial park. The development is focused on the deep sea port, including dry bulk and container trade. Hazardous materials stored in restricted port area, chemistry and ocean equipment industry. The Port committee aims to find synergistic relations between local enterprises. Not just between similar industries but also cross-sectoral relations. It, therefore, also promotes enterprises to invest in the area in order to improve the symbiotic relations.

## Port of San Francisco, USA

The port is responsible for managing around 12km of waterfront where a broad range of maritime, commercial, and public activities are involved in a diverse range of businesses, including cargo and cruise shipping, ferries, ship repair and commercial fishing. Synergies between industries boosted circular economy operations. Port terminals located adjacent to the concrete batching significantly reduced truck trips associated with delivery of raw materials and began the process of co-locating uses that evolved into the Maritime Eco-Industrial Center. This concept was extended by the location of three large recycling operations (including the Sustainable Concrete Crushing for re-use in non-structural concrete and Office White Paper recycling operations). One of the new port projects is a collaborating with the City's Public Works Department on the construction and operations of an asphalt batch plant for the City's street repair projects that utilizes a high percentage of recycled materials processed on site.

## Key findings

- Ports can enable CE activities in other industries - car recycling project in Antwerp, Belgium
- Ports can provide platform for start-ups and pilot projects for further development
- Industrial symbiosis can provide a variety of opportunities to rethink waste stream chains and reduce costs
- Renovation of existing structures, introducing modular buoy systems and innovative operating systems can lower costs and improve everyday operations

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# Conclusions and lessons learnt

**Under 'Circular activities' we cover all physical activities that are implemented in order to maintain or even increase the value of products, materials or waste. The network will focus on high-emitting materials, mainly metals, plastics, cements and biomaterials.**

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The circular economy has an important potential for ports. Port areas are attractive for the recycling industry. The main reason for this is the proximity to cities, industries and the terminals. Ports are therefore important crossroads of all kinds of waste and industrial streams and act as logistical hubs for the flow of waste materials.

Ports bring both the producing and re-using industries in contact with each other for the re-usage of materials in the chain. Ports can stimulate companies and cluster development and activities to produce in a sustainable and circular way in view of creating an added value for the port.
The development and implementation of circular economy strategies requires a renewed cooperation between the various stakeholders (ports, authorities, companies, etc.)

Recycling of waste streams is the most regularly observed activity in ports. Most of these activities are aimed at generic waste treatment and management. Other material flows that are subject of recycling activities comprise (in order of descending frequency): metals, construction materials, plastics, biomass and sludge.

Repair, is also an essential activity within circular economy, as it contributes to maintaining value and reducing waste resources. Such activities are of course strongly related to every port activity since ship repair or repair of tooling is common. The relatively low visibility for 'repair' stems from the fact that port authorities' websites do not always liaise to such activities in their ports.

Industrial symbiosis is also valued when designing circular economy activities in ports. Especially in larger industrial complexes the interconnectivity between industries and their primary and secondary mass flows seems worthwhile exploring further.

Waste should be separated and collected in a good way in order to create a strong business case and companies and consumers should be made sensible.
In some cases we need changes to existing legislation – particularly when it comes to valorisation of residual flows and recycling. Waste and its valorisation are considered as a new business model, but there is a lack of common understanding and interpretation of waste depending on the value.

Perspectives for other LOOP Ports relay on a common interpretation of the end-of-waste criteria (less on a case by case basis) and the administrative procedures.

The transition to a circular economy is a lengthy process that will require legislative perseverance and investment extending over a long-time span in order to create a stable investment climate for the circular economy and an equal level playing field. Harmonized safety requirements and regulatory framework across member states will prevent unfair distortion of competition.
The advance of the circular economy depends to a large extent on technological breakthroughs, scaling-up and the financial aspects of different solutions.

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The LOOP-Ports project is realized with co-financing from the European Knowledge and Innovation Community within Climate; EIT Climate-KIC

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EIT Climate-KIC is a European knowledge and innovation community, working to accelerate the transition to a zero-carbon economy.
Supported by the European Institute of Innovation and Technology, Climate-KIC identify and support innovation that helps society mitigate and adapt to climate change. They bring together partners in the worlds of business, academia, and the public and non-profit sectors to create networks of expertise, to create the innovation that can lead to systemic change.


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