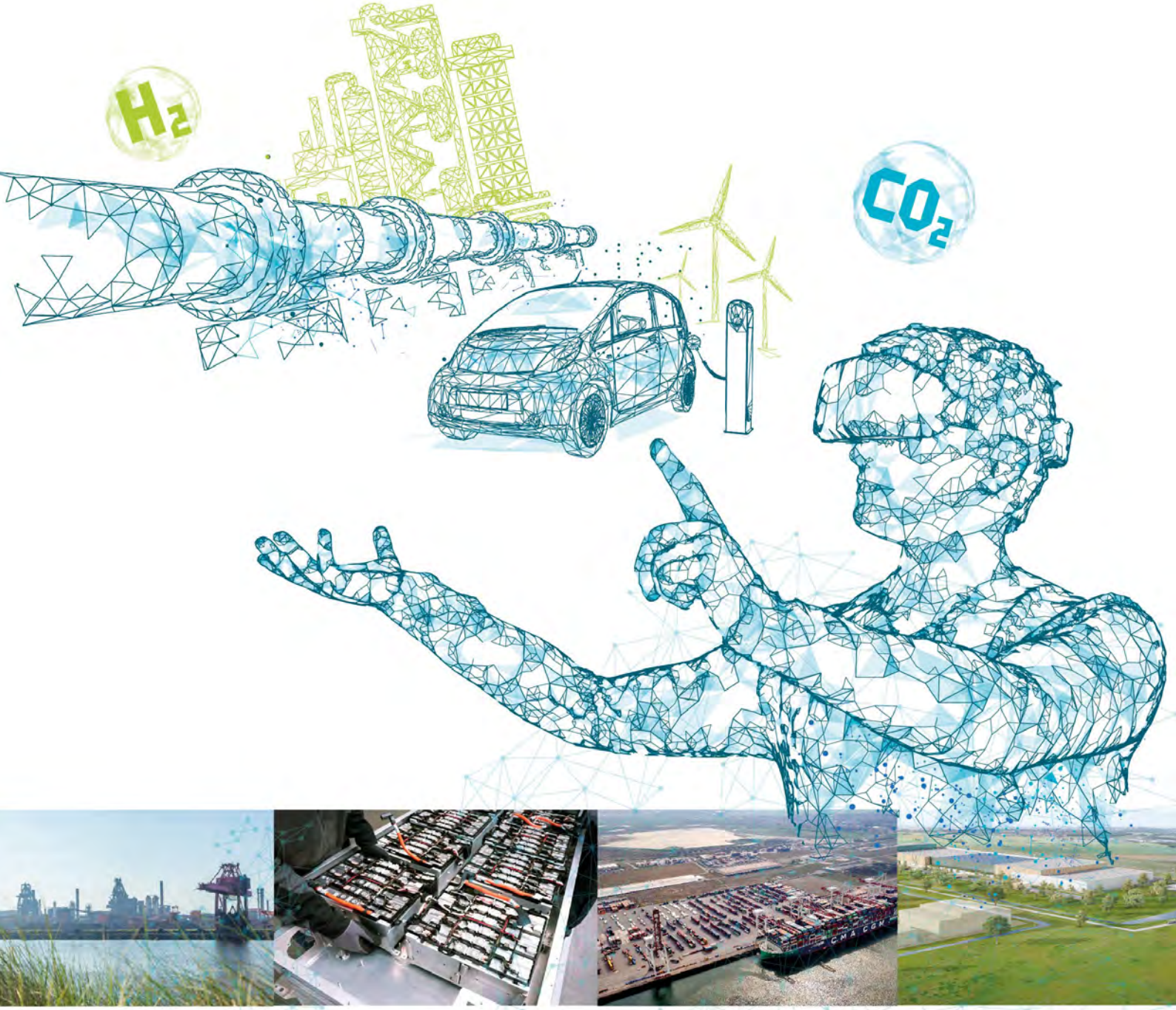


Dunkirk, a region of low-carbon industry and mobility

Patrice VERGRIETE
Former minister of state,
Mayor of Dunkirk,
Chairman of the Greater Dunkirk Urban Council

DECARBONISATION: THE IDEAL TRIPTYCH

Dunkirk is now clearly recognised on a national and international scale as a model region for the low-carbon reindustrialisation of France. Our region has also been known for its collective-led energy transition strategy for ten years now.

In addition to the 20,000 jobs we are going to create, it is this daring collective, this head start we have taken, that I want to remember. We are undertaking major projects: Verkor, Prologium and Neomat have joined us in the last two years. EDF and ArcelorMittal have embarked upon a profound transformation of their Dunkirk sites. But there are other, less imposing players who are just as innovative and representative of the revolution we are leading, who are taking part in this ecological transformation of our region's economic model, like Grain de Sail, a pioneer of sailing cargo ships. It's this head start that the European Union has acknowledged by including us in its NetZeroCities, to support the "100 climate-neutral and intelligent cities by 2030", alongside Barcelona, Antwerp, Copenhagen, Stockholm and Amsterdam.

Just a few months ago, the World Economic Forum selected us as one of the twenty global sites to illustrate "regions that are saving the world".

Such recognition is an honour and motivates us.
Climate change is ramping up. So we must catch up with it in the quest for new industrial sectors and new energy solutions, and also to get our 200,000 residents involved in this daily revolution and to ensure that they are the primary beneficiaries.
In this regard, decarbonisation is the ideal triptych that enables us to reconcile the region's economic development, climate crisis management and environmental challenges.
It's all about building the economy and city of the 21st century.

Here in Dunkirk, we are, of course, thinking about the positive effects that this drastic reduction in greenhouse gas emissions will have on the quality of life of our inhabitants.

This continuing decarbonisation, the driving force behind the development model, permeates all spheres of public policies, from resource management to housing and education in particular, where our collective efforts have helped us to land new engineering courses and recognition for our university as the national spearhead for training in the new areas of industrial decarbonisation.

Dunkirk, the European capital of free public transport, is also innovating in terms of low-carbon mobility and betting on new factories without car parks.

These commitments lie at the heart of the "Climate City Contract" that the Greater Dunkirk Urban Council is submitting to the European Union, along with the Grand Port Maritime, the Chamber of Commerce and Industry and all the economic and institutional stakeholders that make up our Dunkirk ecosystem; this "ÉcosystèmeD" has lent its name to our collective and to a facility dedicated to our new model of low-carbon development, which we inaugurated at the end of 2024.

-55% **Dunkirk is aiming to reduce its industrial CO_2 emissions by 55% by 2030**

16 Mt/year

the quantity of CO_2 from industrial sources emitted in 2021 in the Dunkirk basin, which is aiming to become **carbon neutral by 2050**

100 Kt/year of H_2

will be required to accomplish the decarbonisation projects in the Dunkirk industrial basin between now and 2030

600 MW

the capacity of the wind farm planned off the coast of Dunkirk in 2028

Gravelines Nuclear Power Plant:

5,400 MW

the the total power of the nuclear power plant

2 EPR2

or 3,340 MW, planned for commissioning in 2038/2039

5.3 billion €

will be invested in the industry's decarbonisation over the coming years

Up to

20,000

jobs will be created in the next 10 years

64 GWh

the total power produced by 2030 by the battery industry, representing an €8.5 billion investment and almost 1 million electric vehicles fitted with a battery per year

An area and industry that are heavy consumers of fossil fuels and whose energy consumption mix will be radically transformed

12,329 GWh

energy consumed in the Dunkirk area in 2021, including 18.5% which is electricity

Energy sources breakdown:

81% energy from fossil fuels
10% nuclear energy
9% from renewable energy sources

8,003 GWh

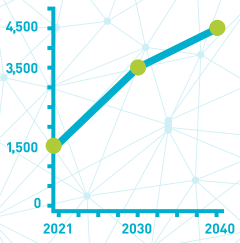
the energy consumed by Dunkirk's industry, including 18% which is electricity or **64.9%** of the Dunkirk area's energy

Energy sources breakdown:

81% energy from fossil fuels
10% nuclear energy
9% from renewable energy sources

1.5 billion €

RTE's investment in the Dunkirk area to upgrade the electricity network



1,500 MW

Electrical consumption in Dunkirk in region 2021

3,500 MW

Anticipated electricity consumption in the region in 2030, requiring RTE to provide 3,500 MW of power

4,500 MW

Anticipated electricity consumption in the area in 2040, requiring RTE to provide 4,500 MW of power

CONTENTS

André FIGOUREUX,
Chair of the Hauts de Flandre Greater District Council

Reducing greenhouse gases, specifically CO_2, is a major challenge for each of us. In its vital role as a facilitator and developer, the Hauts de Flandre Greater District Council is raising awareness among the territory's citizens and businesses on a daily basis. The introduction of a major mobility plan encouraging inhabitants to reduce their use of the car as much as possible (bike network development, car-sharing, long-term bike rent, etc.) and even promoting buying local are simple acts that are beneficial for the planet, stimulate economic development and local employment, plus they are also meaningful in terms of cost and health. We have also launched a solar map, helping us to identify the potential of roofs that could be converted into photovoltaic or thermal energy. Likewise, in partnership with a range of businesses, we are studying avenues for heat recovery and even the introduction of a circular water economy. Finally, for quite some time now we have been supporting the flax sector, a local, natural and sustainable fibre known for its multiple properties.
The Hauts de Flandre Greater District Council (CCHF), a recognised ***"Rev3 Innovative Territory"*** *has, for example, funded a biomass heating plant powered by locally produced flax shives which can heat public buildings such as the Linéo aquatic centre, the Jean Moulin nursery and primary school and EHPAD Résidence du Clocher old people's home.* ***So many initiatives working towards reducing our territory's carbon emissions and contributing to the energy transition.***

Dunkirk, a pioneering territory for the low-carbon industry

Europe and France have set ambitious targets in response to the major challenges brought about by climate change: becoming carbon neutral by 2050.

A historically industrial land, Dunkirk is also the leading national emitter of industrial CO_2 with 20% emissions in 2020. So it's only natural that the territory has been working for over 10 years to decarbonise its activities.

Spearheading this effort is Dunkerque l'Énergie Créative (Dunkirk Creative Energy). It has already taken major strides in favour of more virtuous production models and the circular economy, as well as to support the development of renewable energies (wind, photovoltaic, biogas) and low-carbon energies (EPR2).

The territory's transformation has gained even more momentum over recent years with the arrival and ascent of the battery sector, positioning the Dunkirk basin as France's real **"Battery Valley"**. Aside from that, Dunkirk is preparing for future generations with the creation of training courses that will help to support and accelerate this transition, which has become vital for the territory and, more broadly, for the planet.

Maurice GEORGES

Chair of the Executive Committee of Dunkirk Port

"The appeal of Dunkirk's port is proof of the coherent decisions made over recent years in order to develop the territory as part of the ecological and energy transition.

Becoming carbon neutral by 2050 is a team effort, and Dunkirk Port, which manages and develops a major industrial and port area, is working on a daily basis with the territory stakeholders to promote and back decarbonisation projects.

- *Decarbonising industries by building transport infrastructures (H_2, CO_2, heat, electrical power, gas, process industrial water and seawater, etc.) leading to the development of the circular economy and the emergence of shared services among industrialists. But also by setting up new low-carbon plants, industrial conversion projects and hosting recycling-related deals.*
- *Producing renewable energies with the upcoming construction of two photovoltaic farms, a green hydrogen production plant, the Gridlink electricity interconnector project, the largest offshore wind farm in France and two EPR2s, plus synthetic fuel production projects that are currently under review.*
- *Mobility decarbonisation: France's leading multimodal port, Dunkirk is pursuing its multimodal strategy with the development of the river traffic in conjunction with the Seine-Nord Europe Canal, the deployment of a combined transport plan, doubling the capacity of the Dry Port and the creation of an accompanied combined transport terminal.*
- *The distribution of alternative fuels for ships, with power terminals on the quayside and for port services and hauliers with recharging stations (LNG, H_2, gas, electric) for powering heavy mobility.*

Decarbonisation is one of the key levers for limiting climate change and enabling Dunkirk-Port to adapt to the challenges of tomorrow."

CREATIVE ENERGY, THE DRIVING FORCE BEHIND COLLECTIVE PROJECTS

François LAVALLÉE

First Vice President of the Hauts-de-France Chamber of Commerce and Industry

President of the Calais-Boulogne/Mer Port

Vice President of the Dunkirk Port Board of Trustees

France's third industrial platform, the coastline and Dunkirk area are pioneers in decarbonisation.

The ongoing teamwork of the Chamber of Commerce and Industry, industrialists, local authorities and the ADEME (the French Agency for Ecological Transition) over many years has seen our territory go from the leading emitter of CO_2 to the leading emitter of decarbonisation solutions.

Launched alongside Rev3 on the basis of decarbonisation, this dynamic is a wonderful illustration of a collective coming together to make the territory an experimental CO_2 laboratory and to rise to the major challenge of transforming a constraint into an opportunity, thereby demonstrating the avant-garde vision of the Littoral Hauts-de-France.

Drawing on its diversity and the complementary nature of its stakeholders, the Dunkirk area is today known as a pioneering territory in the quest for solutions and driving forces for energy efficiency, the circular economy, process transformation, etc.

To build a sustainable future, there's not just one solution but a mix of solutions!

ÉcosystèmeD, a key partner in the development, influence and sustainable transition of the region, its businesses and inhabitants.

With financial support from the Greater Dunkirk Urban Council, the Grand Port Maritime of Dunkirk, the Hauts de Flandre Greater District Council, the Littoral Hauts-de-France Chamber of Commerce and Industry and a consortium of more than 120 companies and partners, ÉcosystèmeD is developing a range of services to promote sustainable economic development, improve the appeal of the Dunkirk area and promote the region as a key player in the industry of the future and decarbonisation. Set up as a public interest group, ÉcosystèmeD has a multidisciplinary team working to promote the ecological and energy transition in Dunkirk's industrial and port area and to support companies with their plans to set up, innovate or expand in the area..

Dunkirk, an innovative territory

Dunkirk is one of the 24 winners of the 2019 "Innovative Territories" initiative which was part of the National Investment Plan to develop large-scale innovations. Such recognition led to government aid of €37.5 million of a total estimated budget of €288 million being invested in bringing the territory's transformation projects to fruition. A financial package run and steered by ÉcosystèmeD.

Dunkirk, winner of the "Low Carbon Industrial Areas" call for projects

Dunkirk is the winner of the "Low Carbon Industrial Areas" (ZIBaC) call for projects, launched by the Ministry of Industry through the French Agency for Ecological Transition (ADEME). This arrangement enables engineering and feasibility studies to be conducted into reducing carbon emissions with a 27.2 million euro budget, including a 50% subsidy from the ADEME. Dunkirk wants to become the

first low carbon industrial area, and inspire other industrial territories, both national and international, to follow in its footsteps. These two financial programmes are run and steered by ÉcosystèmeD.

Dunkirk hosts the European Decarbonisation, Industries and Territories Meetings

Founded in 2019 on the initiative of the Greater Dunkirk Urban Council (CUD), Dunkirk-Port, the Chamber of Commerce and Industry (CCI) and major industrial players in the urban area, the European Decarbonisation, Industries and Territories Meetings bring together European economic and institutional stakeholders committed to making the industry carbon neutral. Organised by ÉcosystèmeD, these meetings provide the opportunity for collective exchange and to share best practices in order to accelerate industrial decarbonisation across Europe.

The 6th meeting, organised in conjunction with the 25th European Energy Transition Conference in September 2024, will see the event grow in numbers, with the presence of top executives from French industry, representatives from national and international territories (Belgium, Scotland, Quebec, etc.) and representatives of the French government and European institutions.

Dunkirk joins the CO_2 Club

Bringing together stakeholders in research and innovation across all the components of the CO_2 capture, storage and recovery chain, the CO_2 Club is a place for exchanging information and discussing initiatives among players in the sector's research and industrial sphere. As a member of this club, Dunkirk places itself firmly as a national player in this field.

DUNKIRK, WORLD ECONOMIC FORUM PARTNER

By joining the Transitioning Industrial Cluster Toward Net Zero initiative, Dunkirk is now part of an international dynamic.

Launched by the World Economic Forum and Accenture, this initiative brings together around twenty industrial clusters from all over the world with the aim of exchanging ideas and accelerating the transition by focusing their support and advice on the industrial sectors that emit the most carbon.
The Greater Dunkirk Urban Council and ÉcosystèmeD have given a positive response to this international initiative, which will enable the region to create synergies with other countries and international stakeholders. As the lead on the regional decarbonisation road map, ÉcosystèmeD is working with a group of industrialists to help them reach their emissions reduction targets, particularly by developing collective infrastructures.

In 2024, through the Grand Port Maritime of Dunkirk, the area strengthened its partnership with this global organisation by participating in a report on the **key role of ports in the transition** and preservation of natural areas. **It will be published at the annual meeting of the World Economic Forum 2025 in Davos.**

EcosystèmeD, a building emblematic of industrial transformation

The EcosystèmeD innovation space is a key tool in the transformation of the region and the "Dunkirk, Creative Energy" dynamic. It embodies the region's vibrant transformation and its ambition to remain at the forefront of the energy transition, industrial ecology, the circular economy and industrial decarbonisation. Its two technology halls are home to demos, networking, teaching, researching, facilitation and incubation and therefore contribute to Dunkirk's economic development in connection with current climate challenges.
The ÉcosystèmeD building produces more energy than it consumes as its roof is covered in solar panels and it is constructed with low-carbon building materials. It is home to public and private stakeholders, a school of engineering and a research lab (IMT Nord Europe), an incubator, a showroom and the EcosystèmeD team, which symbolically bears the same name.

A STRONG COMMUNITY INVOLVEMENT TO BUILD A LOW-CARBON TERRITORY AND INDUSTRIAL SECTOR

Frédéric MOTTE
Hauts-de-France regional advisor and delegate for economic transformation.
President of the Rev3 Mission.

As an industrial region at the heart of European exchanges on energy, goods and passengers transport, the Hauts-de-France region is an excellent territory for bringing low-carbon hydrogen to the mass-market. The industry has to respond to ***two significant challenges that lie at the heart of the Rev3 dynamic:*** *making major investments to reduce its carbon emissions and remaining competitive on a global basis. For our territory, the challenge is therefore to have enough low-carbon hydrogen to meet the future needs of our economic stakeholders in a timely and affordable manner. This is the case particularly in Dunkirk, where the low-carbon hydrogen needs will be very significant in the future.*

The massive deployment of hydrogen thus needs transport and distribution infrastructures to be deployed on a regional scale, consistent with the approaches underway in neighbouring regions. *Through its Rev3 initiative and alongside the France Hydrogène regional delegation, the Hauts-de-France regional council brings together the regional hydrogen stakeholders in order to build a shared vision of infrastructure roll-out and facilitate the development and implementation of projects.*

The sector's stakeholders will find in Hauts-de-France a territory fully committed to the third industrial revolution, in favour of the energy transition and for the region's economic development.

Région Hauts-de-France

The Hauts-de-France region is the leading French region in terms of CO_2 emissions. In addition, the success behind this ambitious bet on carbon neutrality between now and 2050 requires the collective involvement of all the main decision makers concerned.

The Hauts-de-France Region and the Chamber of Commerce and Industry have launched Rev3, a dynamic community that aims to make the region one of the most advanced in Europe in terms of the energy transition and digital technology. In line with this, the Region is equipped with a road map and action plan for the development of its hydrogen sector, particularly for transport, buildings and industry, the three fundamental pillars of the Hauts-de-France's economy.

Recognised as a Rev3 Demonstrator Territory, the **Greater Dunkirk Urban Council** is also one of the most advanced in terms of the energy transition in France and in Europe. Committed to tackling air pollution and lowering CO_2 emissions for many years now, the Greater Dunkirk Urban Council is one of the few local authorities to have been awarded the Cit'ergie Gold® label since 2013. This label is awarded by the French Agency for Ecological Transition (ADEME) and assesses the degree to which climate and energy issues are integrated into public policies of local authorities.

DKARBONISATION DUNKIRK, LEADING SOLUTIONS EMITTER

DUNKIRK, EUROPE'S LEADING ENERGY PLATFORM

The Dunkirk territory hosts multiple energy production or exchange facilities (electricity, biofuels, hydrogen, LNG, methane, bio-NGV, heat, cold energy, steam, etc). **The urban area also offers a growing share of renewable energy and has a low CO_2-emitting power-supply mix.**

- **5,400 MW,** the capacity of the EDF nuclear power station in Gravelines, the most powerful in Western Europe. Potentially supplemented by a pair of EPR2 reactors with a total additional capacity of 3,340 MW.
- **28.8 TWh** of CO_2-free emission electricity in 2023. The Gravelines nuclear plant production in 2020 was enough to cover the needs of more than 7 million French homes each year.
- **600 MW,** the capacity of the wind farm planned off the coast of Dunkirk in 2027
- **No.2,** Dunkerque LNG is the 2nd largest LNG terminal in continental Europe, with a storage capacity of 600,000 m^3 at -162°C.
- Dunkirk is France's major import area for gas, hosting the landing terminal **of one of the largest submarine gas pipelines in the world.**
- **40 MW,** the production capacity of solar parks developed between now and 2023 in port areas of Dunkirk.
- **1.4 GW: Gridlink** is a new high-voltage electricity interconnector with a capacity of 1.4 GW between the UK and France, planned for 2030. It will represent a major step forward in meeting both countries' energy needs.
- Dunkirk is also home to TotalEnergie's most powerful **battery electricity storage site in France.** Located in the Flandres facility and with a power of 61 MW, it ensures that the power network remains stable between its consumption and production.
- **Dunkirk has competitive decarbonised energy available, an undeniable asset for industrialists concerned about their carbon footprint and the manufacturing of low-carbon hydrogen.**
  The major energy specialists are all present in the local area: Air Liquide, EDF, Engie, Gassco, GRTGaz, Fluxys, RTE, TotalEnergies, ...

© Quentin Pruvost-Lightmotiv.

Mathias POVSE
Director of Regional Action - EDF Hauts-de-France

Today an industrial zone emitting CO_2, the Dunkirk area can in the future become a reference point for low carbon.

This is the ambition that we're sharing with the Greater Dunkirk Urban Council and the economic stakeholders. The potential studies carried out as part of the Epiflex initiative supported by EDF along with the ADEME show an interest in creating energy symbioses between the port's industrialists in an attempt to ultimately reduce the CO_2 emitted.

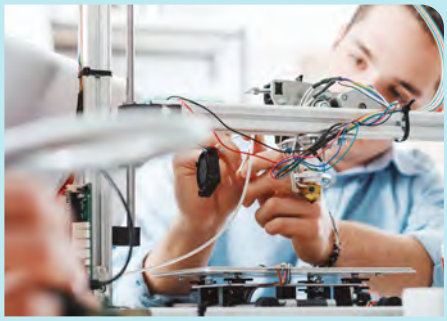
In terms of mobility, the potential need for hydrogen is also significant: public transport, boats, etc. That's why, as part of this project, we are working with our subsidiary Hynamics and the Greater Dunkirk Urban Council on the initial construction of an electrolyser downstream of the waste recycling centre. This would mean that bin lorries and around ten buses could be powered on low-carbon hydrogen by the end of 2024, thus reducing CO_2 emissions by about 1,100 tonnes every year. However, replacing fossil fuels with decarbonised energy, such as the electricity produced by the Gravelines power plant, the port solar park or the offshore wind farm in combination with energy efficiency solutions will be decisive for decarbonisation.

TRAINING PAR EXCELLENCE TO MEET THE CHALLENGES OF A LOW-CARBON INDUSTRY

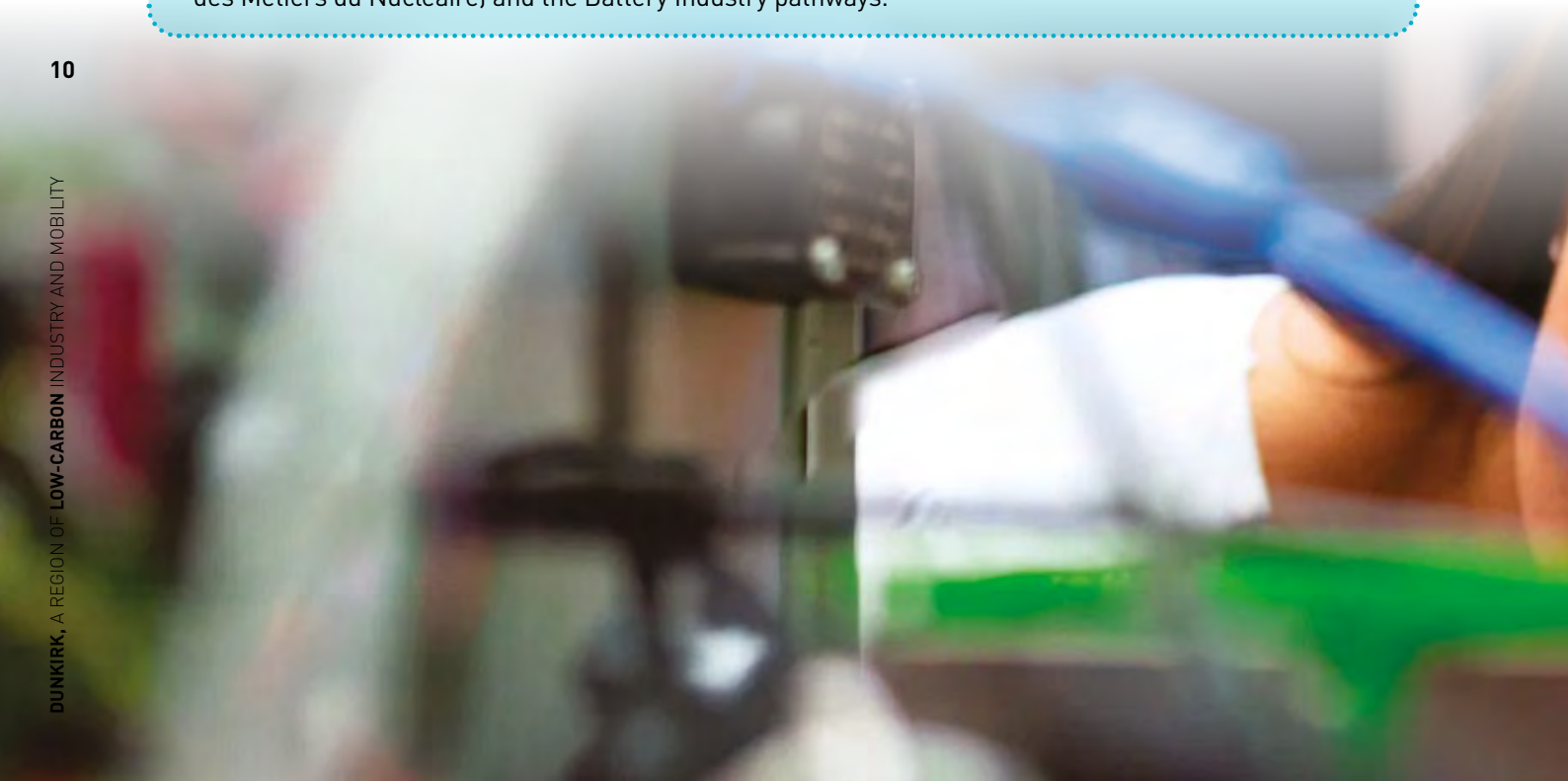
Since the 2000s, **local authorities, companies and the University Littoral Côte d'Opale (ULCO) have been partners in the territory's transformation with a view to setting up** the training sectors of the future.

Today, the Dunkirk area offers a whole host of industry-related training courses. In order to support the territory's transition towards becoming carbon neutral, some existing training courses are complemented by modules on energy efficiency, process electrification, etc. Others have been created from scratch, following the signing of the Local Education Pact, and have been developed in direct conjunction with major local contractors, training centres (AFPA, EPID Vauban, AFPI, FCIL) and provisional skills requirements.

Dunkirk has landed two further energy engineering training programmes since 2020



- **IMT Nord Europe:**
  - offers one energy engineering training with an apprenticeship pathway;
  - is preparing to launch a degree specialising in the nuclear sector in September 2025;
  - is setting up a new laboratory in an EcosystèmeD building in 2025, with a new team of lecturer-researchers.
- **EILCO:**
  The Energy and Environmental Engineering programme will now offer three final-years courses, available to students, apprentices or as part of a professional training contract: Decarbonisation (in conjunction with the C-DéCIDé - Centre of Skills Development for a Low-Carbon Industry), Nuclear Engineering (partnership with the Université des Métiers du Nucléaire) and the Battery Industry pathways.



The Opal Coast, an area of excellence for training in the decarbonisation of industry.

In the pursuit of its efforts to reduce greenhouse gases, the territory has applied to the "Jobs and Skills of the Future" call for expression of interest through the C-DéCIDé project (Centre of Skills Development for a Low-Carbon Industry).

The project has won **€16m in government funding, including €8m directly from the ANR** (National Agency for Research).

Spearheaded by the University Littoral Côte d'Opale ULCO, in partnership with various academic and territorial stakeholders (the Greater Dunkirk Urban Council, Hauts-de-France Chamber of Commerce and Industry and ÉcosystèmeD), the AFPA and local industrialists (ArcelorMittal France, TotalEnergies Raffinage Chimie, Verkor), the project is aiming to make the Opal Coast a national benchmark for training in the decarbonisation of industry. **Unique in France, this "Décarbo Industrie Académie" (Industry Decarb Academy)** is for both initial and continuing education students, as well as professionals who wish to retrain by developing cross-disciplinary skills alongside technical skills, from the certificate of vocational competence right up to a doctoral degree.

6 new technology skills transfer platforms

6 new technology training platforms, called "training workshops", will be interconnected, including the ÉcosystèmeD innovation park, the OLEUM training centre, the Digital Lab, the Afpa (adult education and training organisation), the University Littoral Côte d'Opale (ULCO) and Verkor.

Purpose: To enable employees of partner industries to get an education and obtain micro certifications in specific subjects such as CO_2 capture, multi-energy systems maintenance, waste recovery, etc. New national qualifications in decarbonised industries will eventually emerge.

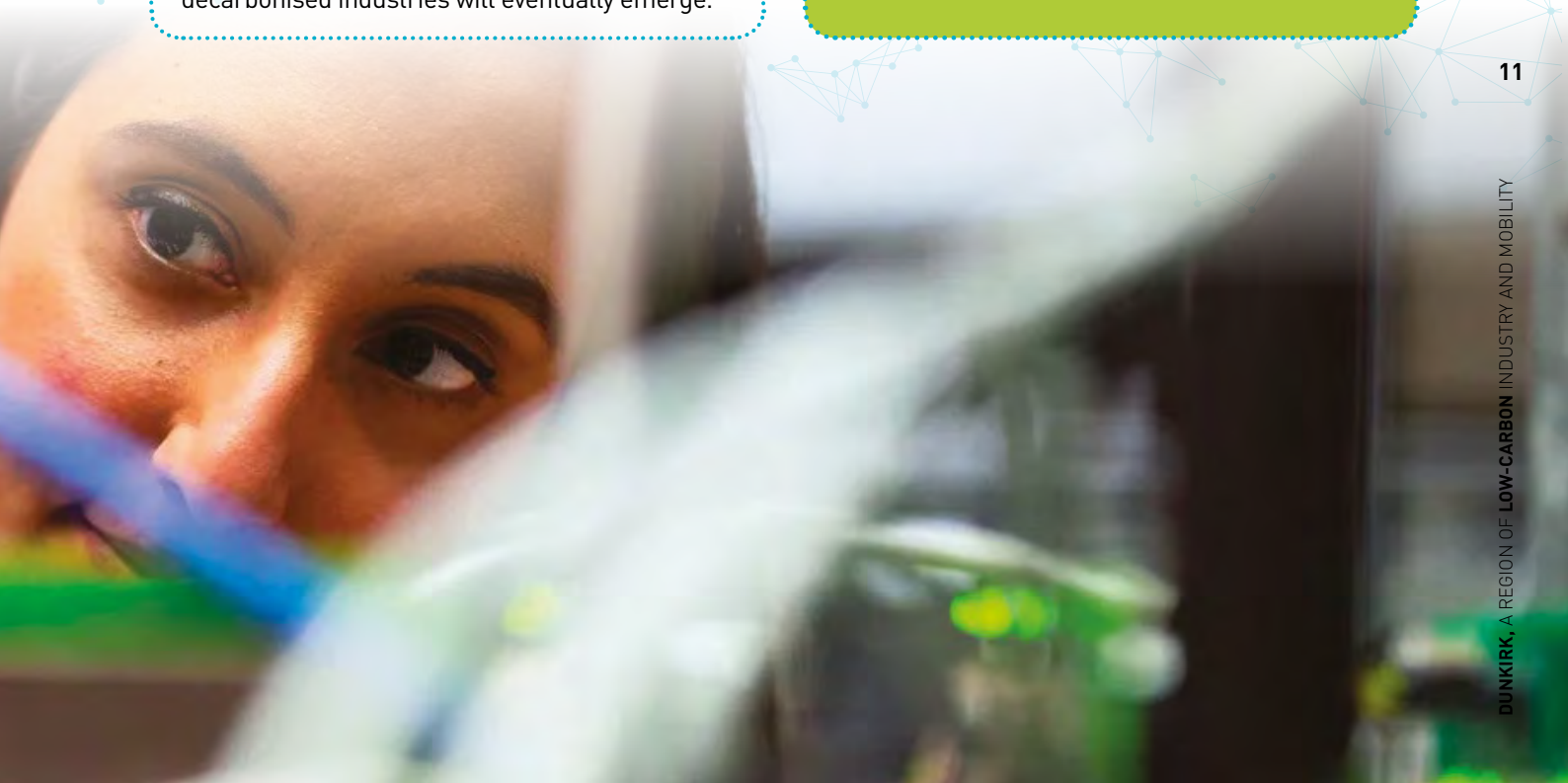
C-DéCIDé's 6 major areas of training

- **CO_2 capture, usage and storage technology**
- **Electrification**
- **Renewable energies**
- **Heat recovery**
- **Industrial process digitalisation and optimisation**
- **The circular economy**

Arnaud CUISSET,

Vice-Chancellor of the University Littoral Côte d'Opale, Representative for major projects and leader of the C-DéCIDé project.

"A project of such ambition could only be rolled out in Dunkirk! For years now, we have been joining forces to undertake major projects for our territory. Thanks to the wonderful community dynamic, we will be able to train several tens of thousands of students and professionals in all the skills the territory needs, from the certificate of vocational competence right up to a doctoral degree. We have 5 years to rise to this challenge and make these new training courses indispensable for the future of the territory's industry, and above all, the future of our national industry."



GAS, BIOGAS AND LOW-CARBON H_2, ESSENTIAL VEHICLES FOR THE TRANSITION

Biogas

In Dunkirk, natural gas represents 1/3 of energy consumption from the industrial and residential sectors (according to the ADEME).

By way of comparison, CO_2 emissions by type of energy consumed:

- **227 grams of CO_2/kWh of gas consumed (CH_4)**
- **80 grams of CO_2/kWh for electricity**
- **44 grams of CO_2/kWh for biogas**

Originating from different sources (agriculture, agri-food industry, contract catering, green waste collection, household waste, etc.), biogas and other renewable gases are an energy substitute for fossil gases.

Renewable gases provide answers to economic and environmental challenges in the way they recover waste and support decarbonisation of industry and transport.

Replacing natural fossil gas with biomethane (biogas that is refined and treated so it has the same properties as natural gas) over time will help to reduce the weight of CO_2 emissions by five.

In Dunkirk, green gas production resources are abundant particularly because of the new methods of green gas production such as pyro-gasification, hydrothermal gasification and methanation, in the process of being industrialised.

A potential of 40 megawatts of green gas can be recovered in the Dunkirk area, which constitutes a major lever in the ambitious carbon neutrality targets and an opportunity for French energy independence.

GRDF (French gas distribution system operator) and GRTgaz (gas carrier) are supporting all the stakeholders in the sector in the Hauts-de-France by way of the Métha'morphose REV3 initiative and contributing to three studies on green gases around the Dunkirk urban area:

- A pilot study on methane pyrolysis with the aim of converting methane into hydrogen without any CO_2 emissions (in the form of solid carbon)

- A pilot oxycombustion boiler study that would help capture and recover CO_2 from combustion

- Contribution to a green gas production input resources study, piloted by Pôlenergie

SPOTLIGHT ON LOCAL BIOGAS PRODUCTION PROJECTS

- **Ch. Daudruy Van Cauwenberghe & fils:** This company has developed an important biomethanation project, called Nord-Métha, inaugurated in July 2023. Its oil refinery processes produce used sludge and fat soils while the biodiesel manufacturing process generates glycerine with high methanogenic power. Over time, the unit will be able to inject 750 nm^3/h of biomethane into the GRDF network, or almost 66,000,000 kWh/year, the equivalent of an annual consumption of 5,800 homes. **This project will avoid 12,000 T of CO_2 emissions per year.** A biogenic CO_2 recovery project is currently being studied.
- **Flandre Biogaz: From 2024, Flandre Biogaz will manufacture biogas from livestock manure and plants (hedges, maize, pea stalks, etc.) produced by 4 local farmers and livestock breeders. The biogas injection volumes in the GRDF network are expected to be between 160 and 190 m^3/hour.**

HYDROGEN SECTOR DEVELOPMENT

Just like other renewable gas and low-carbon sources, hydrogen will play a major role in reaching the carbon neutral target in an affordable way.

Hydrogen can replace the fossil fuels used in certain carbon-intensive industrial processes, particularly in the sectors of chemistry and steel, but also in refining. Hydrogen can also be used as an energy vector for many areas of mobility, particularly heavy mobility, public transport of people and even train transport.

Aside from that, coupled with the development of variable renewable electricity production in Europe and Power to Gas technology, hydrogen will provide a solution for the massive integration of these renewable energies by pairing up various electricity, hydrogen and gas networks.

- **H2V:**

Located in the heart of the port area, the H2V Dunkirk project will be completed in two phases and on two sites:

- **Stage 1 (200 MW):** In November 2022, the project obtained all the prefectural permits needed to start up and produce 28,000 T per year of green hydrogen through electrolysis from 2027
- **Stage 2 (300 MW):** Scheduled for 2029, stage 2 is currently studying the use of electrolysis to produce 42,000 T per year of green hydrogen, helping to avoid 420,000 T of CO_2 per year.

- **SHYMED - HYNAMICS:**

- Green hydrogen distribution and production station

Alongside Hynamics (the EDF group's hydrogen subsidiary), the Greater Dunkirk Urban Council and the French public financial institution Caisse des Dépôts are undertaking the Shymed project to create a 1.25 MW renewable hydrogen distribution and production station next to Dunkirk's Energy Recovery Centre. Hydrogen produced using the electrolysis of water will be employed to refuel the first hydrogen-powered vehicles in Dunkirk urban area (electric buses running on hydrogen and refuse collection trucks).
It will produce up to 540 kg of hydrogen per day and will avoid the emission of 1,137 t of CO_2 per year.

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AN OPEN HYDROGEN TRANSPORT NETWORK, THE FIRST STEP TOWARDS THE H_2 HUB

DHUNE (Dunkirk Hydrogen Universal Network):

Developed by GRTgaz: a hydrogen infrastructure project in the Dunkirk industrial area, with a planned extension to Belgium.

- **Stage 1:** A hydrogen pipeline transport network on the port of Dunkirk in order to connect low-carbon hydrogen production and consumption projects (scheduled for commissioning at the end of 2027).
- **Stage 2:** Extension of the network to Belgium and the integration of a hydrogen terminal spanning around 50 km in total in the port of Dunkirk, scheduled by 2029. The infrastructure will be used mainly for industrial purposes (replacing coke and natural gas with renewable or low-carbon hydrogen) but could also be used for heavy mobility on roads and waterways.

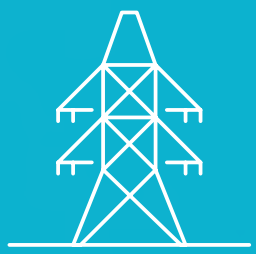
The equivalent of 1 GW of installed or imported electrolysis capacity could be developed, avoiding the emission of 11.1 Mt CO_2 eq/year.

INFRASTRUCTURE DEVELOPMENT FOR DECARBONISATION

Reducing carbon emissions calls for the development of extensive infrastructures around which institutional and industrial stakeholders will rally.

In the local area, infrastructures supported by the Low-Carbon Industrial Area (ZIBaC) scheme are based on 6 major pillars: electricity, water, hydrogen, CO_2, waste heat and gas *(see page 20)*.

At the announcement of the winners of the "Low-Carbon Industrial Area" project, **Roland Lescure,** Deputy Minister for Industry, referred to Dunkirk as a "pioneering" territory, saying: ***"In the future, the region's appeal will be measured by infrastructures essential for the low-carbon industry: electricity, green hydrogen and CO_2 capture. I'm sure that the creation of low-carbon industrial areas across all of France's large industrial basins will help us make it one of the most attractive countries in the world for green industries."***



> Electrification

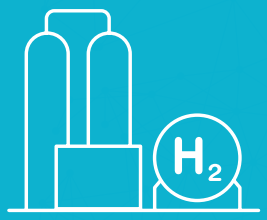
In order to reduce the use of fossil energies, Dunkirk's industrial basin will be relying more and more on electricity, thereby increasing its electricity consumption considerably. Additional needs are estimated at 3,500 megawatts in 2030 and 4,500 megawatts in 2040 (according to RTE). Renewable and low-carbon production of electricity will also see significant growth. Solar parks built in the port area should provide 40 MW of additional electricity and an offshore wind farm will produce 600 MW by 2027. Finally, two new EPR2 will produce 3,340 MW extra by 2038-39. In order to meet the demands of industrial clients and the increase in production means while maintaining optimum power quality, RTE must strengthen its electrical network by optimising its facilities or building new infrastructures such as substations and power lines to supply the area. By 2030, RTE plans to invest 1.5 billion euros in this territory.

> Water

Industry often needs water for its processes. Plus, to limit its use, particularly drinking water, Dunkirk has been building an industrial water network since the 1970s with a capacity of 22 million m^3 of non-drinking water. In addition to that, the territory is supporting the development of "district water", an infrastructure enabling the reuse of industrial water discharged in neighbouring industry processes, and studying the reuse of used water from urban water treatment plants as well as the use of seawater instead of canal water for certain functions. *(See page 19 for more information).*

> Hydrogen

If we are to reach CO_2 emissions reduction targets, we will need to make massive use of hydrogen. Renewable and low-carbon hydrogen can substitute fossil fuels, improve air quality and lead to the emergence of a new industrial sector in France. Following a feasibility study initiated in September by GRTgaz, 11 companies from the Dunkirk basin stated their interest in a hydrogen transport infrastructure in the port and industrial area. Whether we're talking about consumers or producers of hydrogen, the need to develop a public transport infrastructure makes perfect sense. GRTgaz and the territory's decision-makers are working to commission a H2 Hub in Dunkirk, which would eventually be connected to the network in neighbouring Belgium. The hydrogen cluster around Dunkirk will benefit from renewable and low-carbon energies as well as the nearby European Hydrogen Backbone, a specific gas pipeline transport network, largely reusing the already existing gas infrastructures. *(See page 13 for more information).*



> Waste heat

In France, 70% of industrial energy consumption (around 230 TWh in 2021) is used to produce heat, including around 1/3 for low temperatures (<100°C), 1/3 for temperatures between 100°C and 400°C and 1/3 exceeding 400°C. Some processes use heat in excess of 1,000°C, for example, the steel and construction industries (in the production of clinker and manufacture of clay bricks). *In order to complete the already well developed urban heat network in the local area, the Grand Port Maritime of Dunkirk is working with ÉcosystèmeD on a heat superhighway project to recover 635 GWh. This 20 kilometre-pipeline should become the largest network in France shared by industrialists. By 2025, it would transport waste heat emitted by industrialists such as Befesa, Comilog and Ferroglobe and redistribute it among others such as Verkor, thereby avoiding the consumption of energy and emission of CO_2.
**source: Polenergie and je-decarbone.fr*

> CO_2

The Dunkirk territory and its hinterland have set the target of reducing emissions by 55% by 2030 and becoming carbon neutral by 2050. To do so, large-scale community infrastructures are currently being developed. By activating numerous resources (energy efficiency, sobriety, the circular economy, fossil energy replacements, transformation of processes, etc.), we will be able to reduce 60 to 75% of carbon emissions while the remaining emissions will be avoided thanks to techniques for the capture, transport for storage or use of CO_2 (CCUS). As part of this framework, the territory is working together to set up an open CO_2 Hub. *(See page 16 for more information).*

60 to 75%
reduction in emissions thanks to process decarbonisation

25 to 40%
residual emissions capture for use or storage

DUNKIRK'S CO_2 HUB, THE FIRST CO_2 HUB IN FRANCE

Representing emissions of almost 16 Mt of CO_2, Dunkirk's large industrial basin is working to set up a CO_2 Hub. **This infrastructure will help accelerate the decarbonisation of Dunkirk's port and industrial platform and its hinterland** and, thereby, reach CO_2 emissions reduction targets as quickly as possible.

The first phase of the CO_2 Hub, the D'Artagnan project, led by Air Liquide France Industrie and Dunkerque LNG, was recognised as a European Union Project of Common Interest (PCI) and several projects related to CO_2 capture in factories were winners of the EU's Fund for Innovation, particularly Chaux et Dolomies du Boulonnais' CalCC scheme (Lhoist) and Eqiom's K6 programme.

The first CO_2 infrastructure project in France to receive support from the European Union, D'Artagnan would benefit from a grant of more than 160 million euros as part of the CEF-E (Connecting Europe Facility for Energy) funding project if the programme gets the go ahead.

The components of Dunkirk's CO_2 Hub

This project will be composed of a network of pipelines to transport CO_2 and a terminal for reception, liquefaction and storage prior to dispatch or re-use.

The CO_2 Hub will offer collection, transport, liquefaction and intermediary storage capacities for local, regional or national industrialists and could even evolve depending on the stakeholders wanting to use its "nodes" to connect up to it.

The port's CO_2 storage and export terminal would be set up in the immediate vicinity of Dunkirk's liquefied natural gas terminal run by Dunkerque LNG (a subsidiary of the Fluxys group) and whose location is in close proximity to many local industrialists with a direct access to the sea.

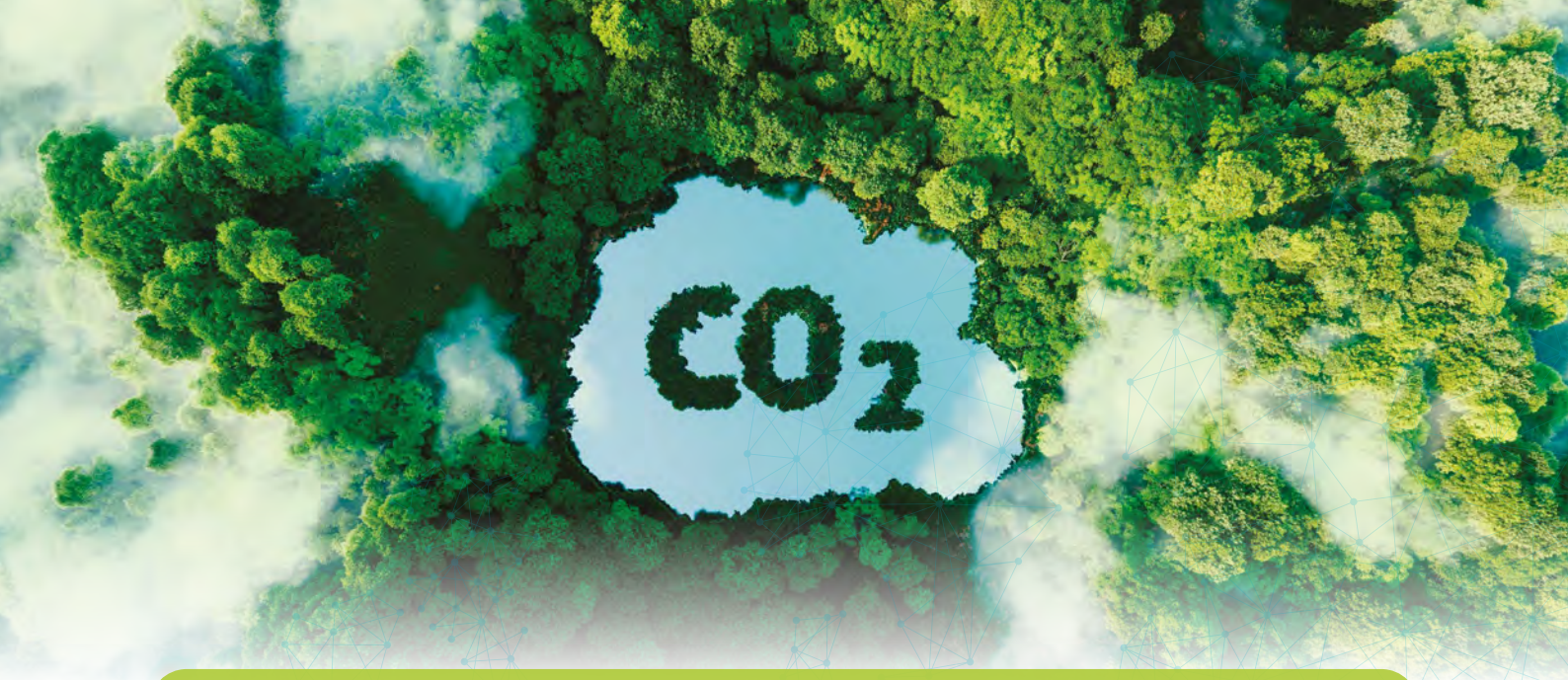
The stored CO_2 could then be either loaded onto suitable ships for dispatch to natural storage sinks in the North Sea, or reused.

The CO_2 terminal's initial planned capacity is 1.5 MT/year of CO_2 collected and dispatched (volumes of CO_2 from Eqiom and Lhoist group's Chaux et Dolomies du Boulonnais), then 2 Mt/year taking into account the connection to the ArcelorMittal Hub. **Additional capacities could be considered,** depending on the needs of the basin's industrialists and the availability of funding. Work on the first sections could begin in 2025 in order to commission the network at the end of 2027.

Essential components in the decarbonisation chain, **permanent storage projects in geological carbon sinks** (deep-sea geological formations) **are one of the levers endorsed by the IPCC** and are backed by the Government as part of the national and European industrial decarbonisation framework. At present, there are important storage sites and projects in the North Sea. They are accessible via the maritime facilities in the Port of Dunkirk.

Reliable and efficient processes for more than 50 years

CO_2 capture, transport and storage processes have proven their reliability and efficiency. As a matter of fact, they have been used for more than 50 years in around thirty CO_2 sinks across the world and have already transported and permanently stored around 300 million tonnes of CO_2.



Isabelle CZERNICHOWSKI-LAURIOL
An international expert on CO_2 capture and storage, President Emeritus of CO_2GeoNet (European Network of Excellence on the geological storage of CO_2), and former associate of the French Geological Survey Office (BRGM).

*“**CO_2 capture, transport and storage in deep geological layers are essential technology in combatting climate change.** “.“Geological carbon sinks” are an additional resource available to help to avoid exceeding the 1.5°C temperature increase specified in the Paris Agreement. As a matter of a fact, despite all the efforts made by industrialists and the innovative technology set up to reduce CO_2 emissions in the atmosphere, residual CO_2 persists. Therefore, it needs to be captured to prevent it from being released into the air and to stop it from continuing to intensify the greenhouse effect. Sending the CO_2 back underground means, in some way, returning it to the place we took it from, since we extract fossil carbon (coal, natural gas and oil) from underground which, when burnt for energy, releases CO_2.*
In the case of Dunkirk's CO_2 Hub, the carbon dioxide will be temporarily stored in surface containers before being transported by boat to geological storage sites under the floor of the North Sea, particularly in Norway, which has had storage sites since 1996”

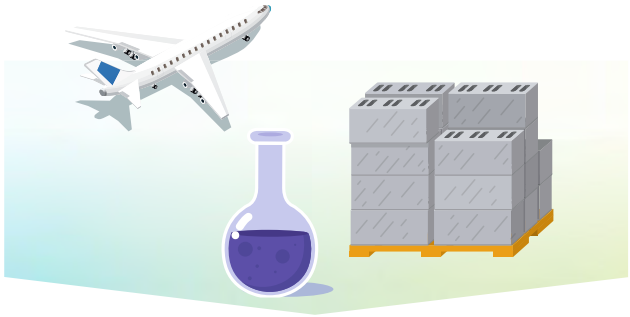
CO_2, a recoverable material

CO_2 is a reusable raw material. The process, which involves capturing it as soon as it leaves the factory, inhibits CO_2 from entering the atmosphere. Stored temporarily, it can then be exported to be stored in natural carbon sinks or be recovered. These solutions are backed by the IPCC and the Ademe.

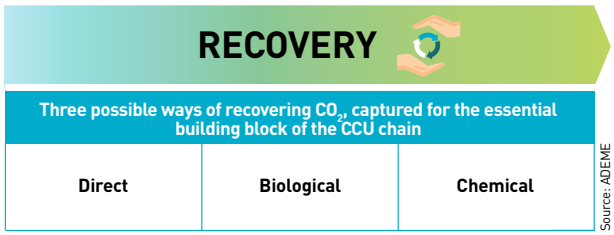
In fact, the chemical components of CO_2 (two atoms of oxygen and one atom of carbon) can be recovered directly (dry ice, refrigerants, etc.) and biologically (cultivation of micro-algae by photosynthesis) or chemically transformed. CO_2 is, in fact, used in a large number of industrial processes (solvents, water treatment, agri-food processes, carbonisation, etc.). Nevertheless, chemical recovery through reaction with another component is the most promising way, giving us as many uses as possible: production of urea, used in agriculture as a nitrogen fertiliser, and salicylic acid, from which aspirin is derived.

CO_2 is also used in the manufacturing process of polycarbonates, a high performance plastic material (optical glass, CDs, DVDs and contact lenses, etc.) and polymethanes (foams, rubbers, etc.). Research into mineralisation and carbonation, particularly to harden concrete, is advanced. Above all, however, researchers are putting a lot of hope into the production of energy products, i.e., methanol, formic acid and fuels at the end of the chain, thanks to a wide range of processes (hydrogenation, reforming, electrolysis, photoelectrocatalysis and thermochemistry).

Uses of CO_2 with the greatest potential



Electrofuels, chemicals, materials



In Dunkirk, several avenues and projects are being explored.

An example of a CO_2 recovery project:

- **Critical Polymers**

Critical Polymers develops innovative processes combining the recycling of plastic and the reuse of CO_2 emitted by the industry.
Critical Polymers first process uses CO_2 in its supercritical state (high pressure and moderate temperature) as a solvent to decontaminate plastics such as flexible PVC. The carbon footprint of this procedure is at least 50% smaller than the production of virgin plastic.

After 4 years of development, Critical Polymers is currently aiming to go to a semi-industrial scale in 2025, with the commissioning of a pilot unit with an annual capacity of several hundred tonnes which will be installed near the port of Dunkirk.
The goal of this fledgling company is to contribute to the circular economy that will make it possible to recover currently unrecycled plastic resources and pave the way for many projects to reuse CO_2.

THE CIRCULAR ECONOMY, SPEARHEADING THE TRANSITION

The circular economy

The Flanders-Dunkirk territory started thinking about industrial and territorial ecology very early on. And today it is demonstrating its expertise and boasts many examples of co-product and utilities recovery. These lasting partnerships are assets and opportunities for any company seeking solutions to decarbonise its business activities or processes. It's also a source of competitiveness.

Here are just a few examples:

- ✓ **Ecocem** recovers slag from ArcelorMittal.
- ✓ **Aquanord** and **Dunkerque LNG** benefit from the hot water from the nuclear plant.
- ✓ **The urban heat network** provides heating for more than 16,000 homes or public buildings using calories from local industries.
- ✓ **The DK6 combined cycle power plant** recovers the blast furnace and coke oven gases from ArcelorMittal.
- ✓ **Ryssen Alcools works with the IndaChlor factory** which delivers waste heat in the form of steam, meaning Ryssen can shut down all or part of its gas boilers.
- ✓ **The Dunkirk area was the first** to have its own **Toile industrielle®** or industrial decision-making tool (from AGUR urban planning and development agency).
- ✓ **The Dunkirk region is also a pioneer** in France in industrial and territorial ecology, particularly thanks to the creation of a specialist organisation called **"Ecopal".**

TOWARDS DISTRICT WATER

The domain of water is no exception to the territory's approach to industrial ecology, and **water resources** have been a major challenge for over 50 years.

An international pioneer, the territory has had its own specific so-called "industrial" (non-drinking) water network since the 1970s. Taken from canals, industrial water enables fourteen companies in the port and industry fabric to use up 22 million m^3 of non-drinking water.

Faced with the challenge of protecting global water resources yet always at the forefront of this matter, the territory's stakeholders (industries, government services, GPMD and local authorities) have rallied together to anticipate the impacts of climate imbalance and the needs required for new facilities and industrial decarbonisation (particularly the production of hydrogen):

- By helping to **optimise the consumption** of each industrial customer, whether they are already established, in the process of setting up or planning to set up (portage by the GPMD, Dunkirk Water Syndicate and ÉcosystèmeD);
- By encouraging **a circular water economy involving the reuse of wastewater from each industrialist** for a neighbouring industrial plant process (portage by the Dunkirk Water Syndicate and the GPMD);
- By diversifying the **sources of non-conventional water** with short- and medium-term reuse of used water from urban wastewater treatment plants, while studying the use of seawater instead of canal water for certain functions (portage by the Greater Dunkirk Urban Council, GPMD and ÉcosystèmeD).

By undertaking these initiatives, the Dunkirk port and industrial territory wishes to become the benchmark and industrial-scale demonstrator for the proper use and innovative development of non-conventional water across Europe.

1.02 Mt of CO_2

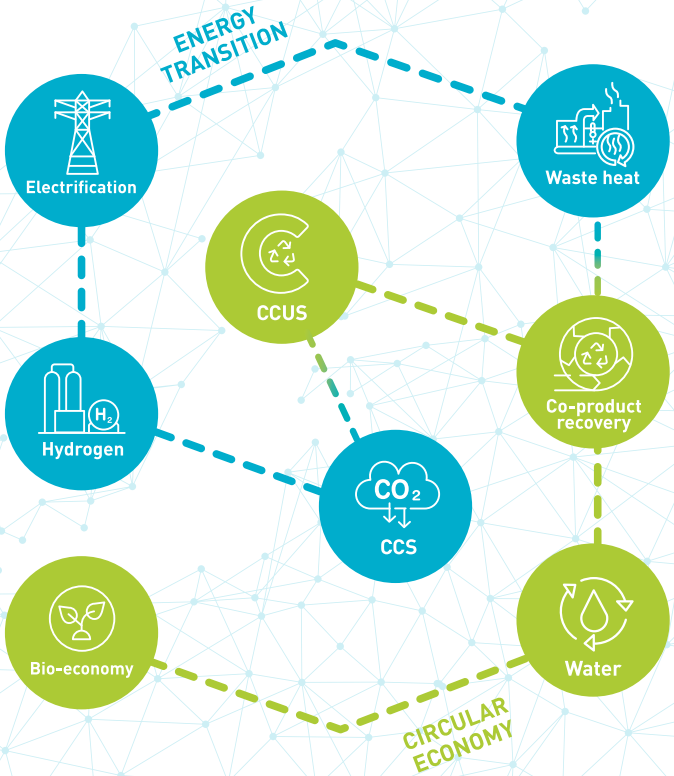
In the Dunkirk region, 1.02 Mt of CO_2 is avoided every year thanks to industrial and territorial ecology.

INDUSTRIALISTS COMMITTED TO CARBON NEUTRALITY

Dunkirk and its hinterland are home to the industrial sectors which, because of the nature of their processes, are some of the biggest CO_2 emitters: cement production accounts for 5% of emissions, the chemistry industry is 4.1%, the iron and steel industry is 4% and the production of aluminium and other metals is 1.2% *(Source: a study by the World Resources Institute).*

Therefore, local stakeholders in these sectors are naturally rallying together and activating all the levers at their disposal.

- ✓ **Energy efficiency and sobriety**
- ✓ **Circular economy**
- ✓ **Electrification and process transformation**
- ✓ **Use of hydrogen or biogas**
- ✓ **CO_2 capture, transport and storage**
- ✓ **CO_2 use and recovery**



OVERVIEW OF LOCAL PROJECTS

ARCELORMITTAL

- **Smart Carbon Project**

The centrepiece of the Smart Carbon initiative is the partial replacement of coal in blast furnaces with other sources of circular carbon from waste flows, such as sustainable biomass from farm or plastic waste.
The Smart Carbon sector also facilitates the integration of carbon capture and reuse (CCU) or storage (CCS) technologies. The carbon emitted is captured during the steelmaking process, making the industry potentially carbon neutral.
Furthermore, the carbon captured at the end of the process will be able to be recycled and used by other industries, contributing to the production of carbon-neutral biomaterials.

- **Steel Recycling**

Recovering used steel (cans, cars, building materials, ships, etc.) and reworking it into the production process. Eventually, steel produced by ArcelorMittal in France will contain up to 25% recycled steel.
Objective: -1 Mt of CO_2 per year

- **Net zero project**

Replacing the CO_2 generating blast furnace process with the electrical furnace process, using pre-reduced iron ores (Direct Reduced Iron process) and recycled steel. With respect to this project, ArcelorMittal have joined forces with the territory's stakeholders to transform the steel production process by developing innovative solutions using low-carbon hydrogen and CO_2 capture technologies to reach carbon neutrality by 2050.
Objective: -4.6 Mt of CO_2 per year


Pilote industriel DMX™ - IFPEN

AMELI GREEN LIME SOLUTIONS PROJECT

Producing very high quality lime with a minimal environmental impact.
The AMELI project is rallying its partners around a common strategy for reducing their carbon footprint and is aiming to become part of the industrial ecosystem for decarbonisation in Dunkirk, with the potential to develop a circular economy, particularly through using biomass and CO_2 capture and recovery once the infrastructure is put in place.
Objective: In time...zero-carbon lime

ALUMINIUM DUNKERQUE

The electrification of processes and the elimination of single-use plastics are leading to a growing demand for aluminium. Because of its recyclable and lightweight properties, aluminium will be increasingly used in the automotive and transition sectors (solar panel constructions, batteries, etc.). In addition, Aluminium Dunkerque, which already emits 4 times less greenhouse gas than the world average for its sector, will increase its production while seeking to reduce its carbon emissions: -30% in 2030 and -70% in 2050 (scope 1,2 and 3).

- **LowCAl Project**

A new smelting furnace - Recycling several thousand tonnes of aluminium and producing up to 20 Kt of additional metal each year from 2025 will significantly reduce environmental impact (CO_2 emissions and energy consumption).
Objectives: -10% CO_2 emissions on average for ingot production and 96 GWh of electricity consumption avoided per year from 2025.

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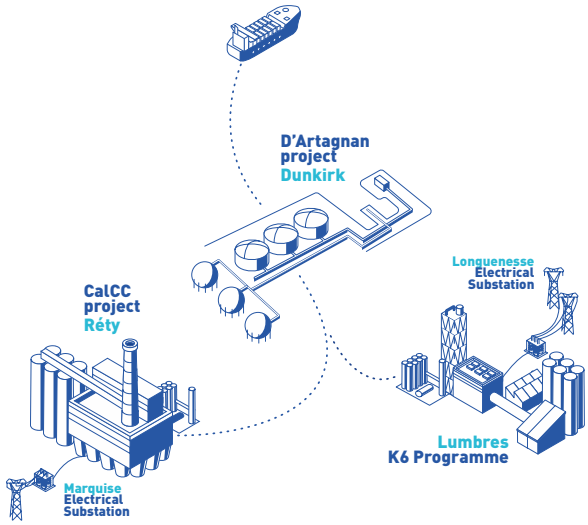
CAP DECARBONATION

"Cap Décarbonation" is the name of the shared carbon emissions reduction scheme bringing together three complementary projects: Stage 2 of the K6 Programme in the Lumbres cement factory, the CalCC project at the Réty lime production plant and the D'Artagnan project involving the CO_2 transport pipelines and the terminal in the port of Dunkirk.



Five businesses are involved: Eqiom, Lhoist (Chaux et Dolomies du Boulonnais), Air Liquide France Industrie, Dunkerque LNG and RTE. The aim of the scheme is to capture the residual CO_2 inevitably emitted by Eqiom and Lhoist in their industrial processes, purify it using AirLiquide's CryocapTM technology and transport it via an 80 km-network of underground pipelines to a CO_2 terminal (planned to be located close to the Dunkerque LNG liquefied natural gas terminal) in the port of Dunkirk. Stored temporarily, this CO_2 could then be loaded onto suitable ships for dispatch to natural storage sinks in the North Sea.
Objectives of this shared initiative: - 1.5 M tonnes of CO_2 per year.

©Michel Guilbert

IMERYS

The site manufactures special binders (calcium aluminate cement) intended for the building chemistry and refractory markets to produce 280 Kt of clinker and 170 to 180 Kt of cement per year. There are plans to expand the site to host new low-carbon projects:

- **AGGLO** for raw materials diversification
- **FIT:** a new furnace to reduce CO_2 emissions by using low-carbon raw materials and to develop the use of more sober energy sources (natural gas, hydrogen). In 2022, pilot testing phases and feasibility parameters as well as sizing of the future semi-industrial facility have been finalised.
Following the receipt of DEMIBaC funding (ADEME).

- **PRECIZE:** Production trials and validation of cement quality using hydrogen (planned for 2025).

These two investments amount to a total of more than 30 million euros.

Result: A potential reduction of 40,000 tonnes of CO_2 (50% CO_2 reduction compared to clinker produced traditionally) per year has been identified for the Dunkirk site. Furthermore, as part of the development of the FIT Project, an additional reduction of around 40,000 tonnes will be achieved at constant production volumes. (100% reduction of CO_2 compared to clinker produced traditionally).

DILLINGER FRANCE

Since 2013, Dillinger France has been working to improve its energy performance, implementing ISO 50001. The company has been taking actions to reduce its energy consumption such as applying a variable-frequency drive across almost all its electric motors, compressed air consumption optimisation, LED relamping of its workshops and offices, recovering heat from all the reheating furnaces and optimising minimum consumption levels when plant is not up and running.
Dillinger France has won €1,8 million grant from the ADEME as part of the Government's call for projects on "Energy efficient processes and utilities in the industry". It is the only Dunkirk project to be selected from among sixteen nationwide.
Result: This grant has helped to support the renovation of one of the two powerful ovens in which **Dillinger France has invested 10 million euros and will help to reduce their CO_2 emissions by 2.7%.**
Other projects are under consideration, such as the integration of hydrogen into the natural gas being fed into its furnaces, or capturing part of the CO_2 emissions for storage purposes.
A study is also being conducted about reducing the impact of the process on water resources.

BALL PACKAGING

Ball has ambitious low carbon objectives.
Objective: 55% reduction in overall CO_2 emissions by 2030 (year of reference = 2017, scope 1,2 and 3).
For the Bierne site, a gain of 30% to date or almost 40,000T of CO_2 per year, particularly thanks to:
- A change of metal (from steel to aluminium)
- Lighter cans
- Saving on compressed air
- Compressors equipped with variable frequency drive (supported by ADEME)
- Pipe insulation (supported by ADEME)
- Heat recovery (supported by ADEME)
- Optimisation of process setups
- Use of biodiesel for road freight

On the other hand, 40 % water savings in comparison to 2017, or about 55,000 m^3/year. Other projects are under way or being studied to make further progress in these two areas.

COCA-COLA EUROPACIFIC PARTNERS

CCEP's objective: - 30% CO_2 emissions by 2030 (compared to 2019).
On the Socx site:

- Reduced gas (CH_4) consumption using a heat recovery network on 40 bar chillers and compressors;
- Substitution of CO_2 for nitrogen (N2G) in some of the production processes.

Result: reduction of site's carbon footprint by 15% with an increased production capacity.

- Reduction of packaging weight and the distance products are transported, and soon a fleet of 100% electric forklift trucks;
- Under review with a consortium of industrialists: oxycombustion of heating plant burners with CO_2 capture/filtration directly in the stack..

SITE COCA-COLA EUROPACIFIC PARTNERS

KUBOTA FARM MACHINERY EUROPE

Kubota Farm Machinery Europe (KFME) is committed to an energy optimisation scheme in order to reduce its consumption:

- An energy meter plan for each piece of equipment with digital supervision (consumption monitoring across 13 pieces of equipment running on gas and 29 electric equipment boxes) which will raise an alarm in the event of a fault and help users understand which pieces of equipment are most energy-intensive and prioritise areas of improvement;
- Air flow from air treatment units is limited to the actual ventilation requirements (Return on investment over 1.3 years);
- Paint reformulation to reduce the time it takes to dry parts.

ASTRAZENECA

The Anglo-Swedish laboratory will be increasing its aerosol drug capacity and in doing so will make the most out of its opportunity to decarbonise its business with improved gas propellants. This is **a new investment plan worth around 365 million euros** for the Dunkirk plant, which produces four inhaled medicines in aerosols, indicated for the treatment of asthma and chronic obstructive pulmonary disease (COPD). The project is expected to create around a hundred jobs.

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Photothèque Air Liquide - Adrien Daste

DUNKIRK AT THE HEART OF FRANCE'S BATTERY VALLEY

The major obstacle in the way of France's aim to become carbon neutral by 2050 is reducing greenhouse gas emissions in the sectors with the highest emissions: energy (41% emissions), transport (24%) and construction (24%). - Source: IEA, 2021, World Energy Outlook.

Electric car development seems to be one of the solutions to reducing these gases. However, the issue of the strategic metals needed to manufacture electric batteries and their end-of-life recycling is a hot topic. In July 2023, the European Council adopted a new regulation that aims to promote a circular economy while regulating batteries throughout their life cycle. Specific recycling efficiency targets have been set at 80% for nickel-cadmium batteries and at 50% for other battery waste from now to the end of 2025.

The issue of reusing and recycling these metals and, more largely, the circular economy, is at the heart of e-mobility. The Hauts-de-France region, the leading automotive region in France with seven manufacturing sites, 800 businesses and 55,000 employees in the sector, particularly in Dunkirk, is moving in this direction with several large-scale industrial projects.

7 major projects in the territory: from battery production to recycling

In just a few years, Dunkirk has become the centre of **France's battery valley,** which includes Verkor's gigafactory for the production of battery modules (by 2025), Neomat's cathode production and recycling plant (by 2026), Prologium's lithium ceramic battery manufacturing factory (by 2027), and more recently, Enchem's setting up of an electrolyte production plant. Moreover, Borax France announced a lithium conversion programme and Eramet-Suez is undertaking a recycling project. These facilities will complement the regional sector: ACC in Douvrin, Envision in Douai and Tiamat in Amiens are located less than 200 kilometres from Dunkirk.

A total of almost 8.5 billion euros will be invested over the coming years in the port and industrial area to produce and recycle electric batteries (for a total power of around 64 GWh by 2030).

Dunkirk, an ecosystem encouraging the emergence of the battery industry.

THE TERRITORY HAS MANY ASSETS TO ITS NAME:

- **The 3rd largest port in France,** boasting an excellent connection to logistics networks.
- **A strong industrial culture,** a dynamic ecosystem.
- **Turnkey sites** helping companies to get up and running quickly.
- **Effective cooperation** between all the area's stakeholders.
- **Raw materials** (steel, aluminium) and low-carbon energy.

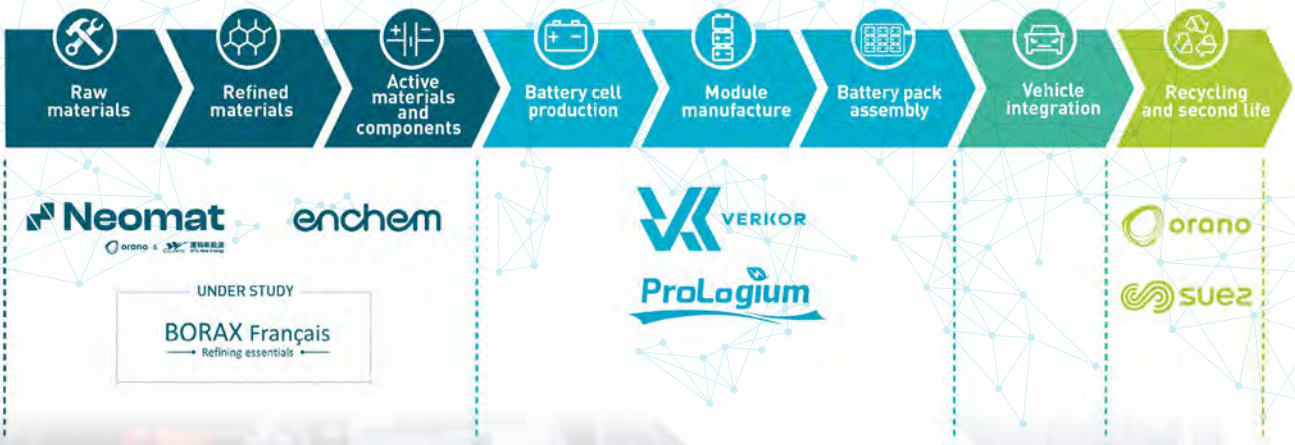
170,000 tonnes per year of so-called "electrical" steel will be produced by ArcelorMittal Mardyck from 2025, representing a 500 million euro investment. This steel is intended for electric motors in general and is characterised by its magnetic and mechanical properties.

60,000 tonnes of alloy ingots for the automotive sector will be produced by Aluminium Dunkerque from 2025. Aluminium is used to make vehicles lighter.

Emmanuel Macron, *President of France during his trip to Aluminium Dunkerque in 2023*

More aluminium is required for the production of electric vehicles than for the production of internal combustion vehicles.
The use of this metal, which is very light and a good conductor, is becoming greater and is now predominant in the construction of engine blocks and batteries. At present, Aluminium Dunkerque produces 40,000 tonnes of alloy ingots for the automotive sector and is aiming to increase this capacity by 50%. Of the additional 20,000 tonnes, a third will be made up of aluminium recycled from end-of-life vehicles.

Value chain for vehicle electrification



Thomas BRION

Project Director for the P-CAM and CAM plants in Dunkirk

"Against a backdrop of very significant electric vehicle growth in Europe, Neomat are delighted that our project has been selected by Dunkirk Port to host three plants for the manufacture of P-CAMs and CAMs and for recycling. This wonderful project should not only meet the needs of car manufacturers and gigafactories but also contribute to the creation of skilled jobs that will add value to a context where there are major challenges around the climate and industrial autonomy."

NEOMAT :

Joint-venture between Orano and XTC New Energy

Expertise: Orano, an internationally recognised expert in the area of nuclear materials.
Recognised as one of the world leaders in the production of energy storage materials, XTC New Energy is committed to supplying advanced material solutions to help achieve Net Zero targets.

Project: Orano and XTC New Energy have signed agreements with a view to creating two joint ventures involving the production of cathode active materials (CAMs) and their precursors (P-CAMs) for electric vehicle batteries, as well as a shared Research & Development laboratory.
When it comes to these two plants, which will be built on a 50 hectare site in Dunkirk, the two industrial groups plan to have mirror-image shareholding and governance: Orano will hold 51% and XTC New Energy will hold 49% of the P-CAM plant, and XTC New Energy will hold 51% and Orano 49% of the CAM plant. These plants will primarily use NMC (a combination of Nickel, Manganese and Cobalt) technology, which is mainly employed in Europe and essential for the production and performance of electric vehicle batteries. Orano is also planning to set up and run a battery recycling factory on the same site near the P-CAM and CAM manufacturing facilities. This comprehensive project should help to create a complete and sustainable value chain in France and meet both France and Europe's decarbonisation targets.

Completion dates: CAM plant production start: 2027

3 plants

1 R&D laboratory

50 hectares

1.5 billion euro investment

1,700 jobs created

Getty images, juan maria pazos alfonso

Orano – Cyril Crespeau

PROLOGIUM:

Expertise: World leader in lithium ceramic battery development and manufacture.

Project: Setting up a gigafactory for the production of lithium ceramic batteries for electric vehicles.

Completion dates: Start of construction in 2025, start of operational activity in 2027.

5.2 billion euro investment

3,000 direct jobs

130 hectares

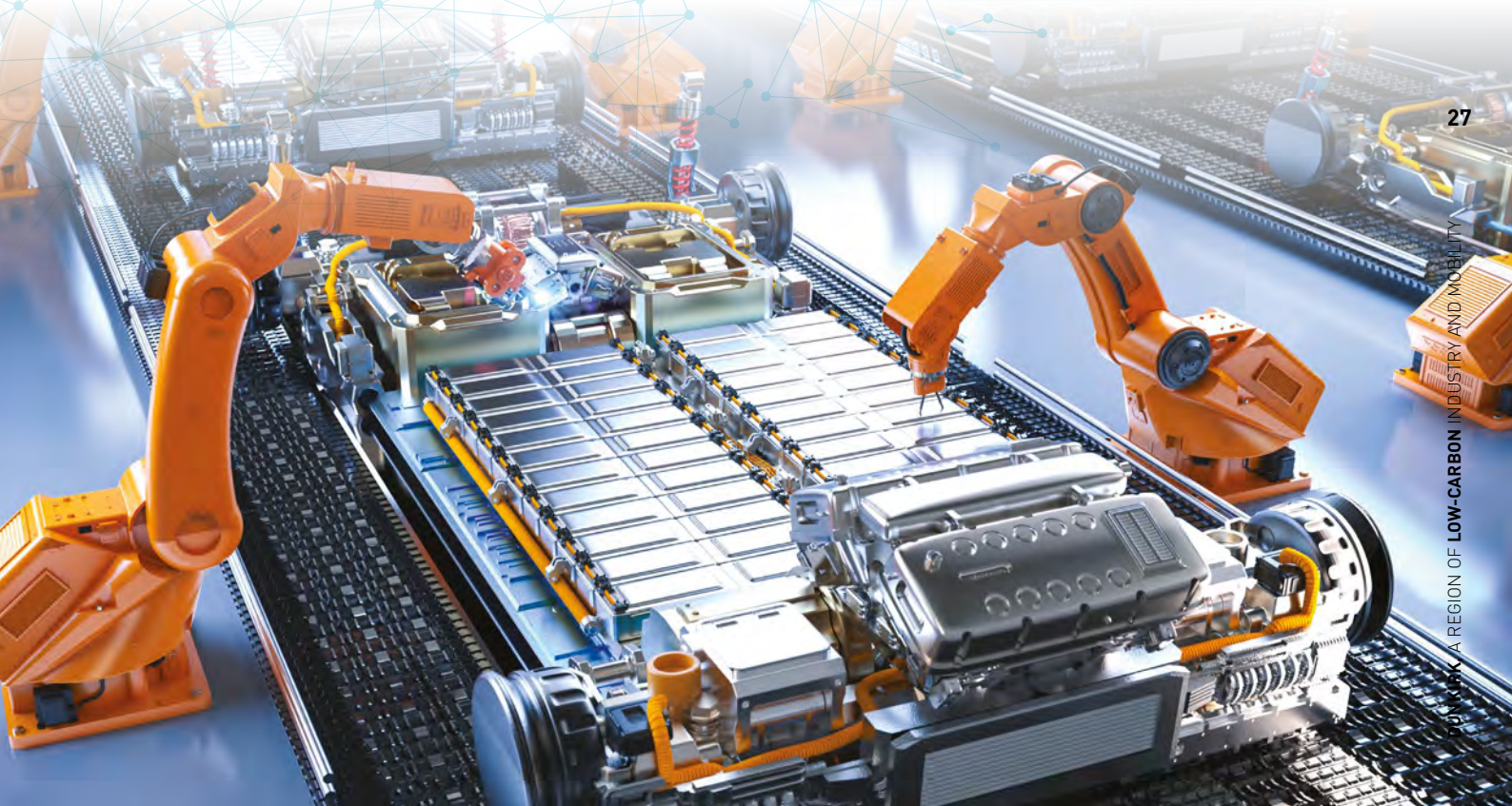
When completed, the plant will have an annual capacity of 48 GWh.

Vincent YANG

Founder and Chairman of ProLogium

"To accelerate the transition towards low carbon transport, ProLogium is committed to introducing to the daily life of the wider public lithium ceramic batteries that combine exceptional performance, commercial viability and a reduced environmental footprint. Setting up a gigafactory in Dunkirk is key to this objective. Located in the "Battery Valley" in the Nord region of France, this production centre will benefit from low-carbon energies and, at the same time, from the power of this battery ecosystem and the talent of the Hauts-de-France region."

Read the full testimonial by scanning the QR code



VERKOR:

Expertise: Low-carbon, high performance battery production.

Project: Setting up a production unit for electric battery modules intended mainly for the automotive sector.

Completion dates: Gradual commencement of activity in 2025 (1st phase), final completion in 2027.

1.5 billion euro investment

1,200 direct jobs

150 hectares

16 GWh of power developed by 2027

300,000 vehicles per year with an electric battery

4 to 5 times smaller carbon footprint than batteries made in China

Benoit LEMAIGNAN
Co Founder & CEO Verkor

"Since July 2020, Verkor has set itself a challenge: to accelerate low-carbon, high-performance battery production in Europe. Led by talented teams and committed partners, we are proud to be developing a more environmentally friendly model of mobility and, thus, driving forward the energy transition. After opening our Verkor Innovation Centre in Grenoble, the inauguration of our first gigafactory in Dunkirk ushers in a new chapter, work on which has begun at the end of 2023. Our set-up in the Hauts-de-France helps us get involved in the creation of a new battery industry-related ecosystem while integrating the whole value chain from material and equipment to recycling."

BORAX FRANÇAIS:

Expertise: With a long-standing history in Dunkirk, Borax France converts boron oxides into speciality borates.

Project under review: In terms of historical business, the site has developed boric acids for the cathode market and is studying the installation of a new dedicated line.
The group is studying the feasibility of opening a line for the production of up to 12,000 T of lithium hydroxide per year, an essential component in the manufacture of electric batteries. The current study is looking at the best options for integrating the new service, in order to optimise water consumption and meet CO_2 emissions reduction criteria.

SUEZ:

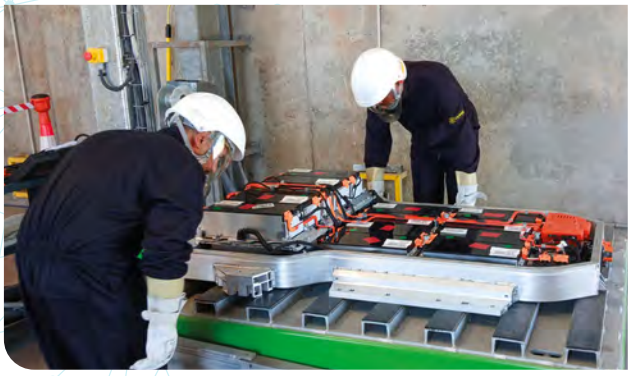
Expertise: Lithium-ion battery recycling

Project: SUEZ, a leader in circular solutions for water and waste, have chosen Dunkirk as their recycling factory for lithium-ion electric vehicle batteries.
In fact, SUEZ have expertise in the collection, sorting, preparation, dismantling and recycling of battery waste.
The project is to make Dunkirk the home of the dismantling factory and the production site for blackmass, a metallic concentrate of nickel, cobalt, manganese, lithium and graphite.

Completion dates: Commissioning is set for 2026.

50 kt of battery modules per year | Equivalent of 200,000 electric vehicle batteries

5 hectares



ENCHEM:

Expertise: Leader in electrolyte production

Project: Setting up an electrolyte production factory for batteries, NMP* recycling and cathode suspension production.

* Essential solvent for the production of lithium-ion batteries, fostering the cohesion of battery components and the performance of separators.

Completion dates: The production of electrolytes, cathode suspension and the recycling of NMP are scheduled for 2027.

57 million € investment

100 direct jobs

5 hectares

150,000 tonnes of electrolytes

BY IMPLEMENTING A COMPLETE DECARBONISATION CHAIN, **DUNKIRK IS AIMING TO REDUCE ITS CO_2 EMISSIONS BY 55% BY 2030.**

EDF EPR2 Gravelines
Preliminary architectural view subject to change
© SANTER VANHOOF ARCHITECTES

2021 > 2026

- CIRCULAR ECONOMY
- ENERGY EFFICIENCY
- HEAT SUPERHIGHWAY
- ADAPTATION OF SEVERAL ELECTRICAL SUBSTATIONS

2027 > 2029

- ELECTRIFICATION OF INDUSTRIAL PROCESSES
- LOW-CARBON HYDROGEN PRODUCTION
- CAPTURE OF RESIDUAL CO_2 (TRANSPORT, STORAGE, REUSE)
- RENEWABLE ENERGY PRODUCTION (WIND, PV)
- WATER MANAGEMENT OPTIMISATION
- IMPLEMENTATION OF A NEW SUBSTATION

2035 > 2050

- 2 EPR REACTORS
- 2050 > CARBON NEUTRALITY

Bruno BONNEL
General Secretary for Investment for the France 2030 plan

As France's port and industrial area with emissions of more than 15 million tonnes of CO_2 eq per year, or around 20% of CO_2 eq emissions from French manufacturing and construction industries, the Dunkirk territory is leading many projects for the decarbonisation of industry. This is exactly the case with Dkarbonation, a project submitted as part of the ZIBac call for projects (Low-Carbon Industrial Areas Support and Development Scheme). Backed by the French Government as part of France 2030, this programme aims to accelerate the decarbonisation of the top ten industrial areas with the highest levels of emissions by providing them with support to consolidate consortiums, encourage partnerships in order to elicit synergies among industrialists, identify the infrastructures required and conduct the research needed for a joint decarbonisation action plan.

The Dkarbonation project aims to meet the targets set by the ZIBaC, particularly concerning the difficult issue of the development of energy infrastructures, hydrogen and carbon dioxide networks, which need to be synchronised with decarbonisation projects and industrial investments.

This ambition mobilises the territory's many stakeholders (industrialists, local authorities, infrastructure managers, economic development stakeholders, etc.) and enables the implementation of a coordinated strategy, which includes the topics of land use, thanks to shared infrastructures in particular, while guaranteeing coherent industrial projects in the territory. All of the foregoing help to reinforce the territory's economic appeal and ensure local employment thanks to a major upstream training section.

First, the TIGA programme (Territoires d'innovation de grande ambition - programme for innovative territories with major ambition), then the ZIBaC and in the future gigafactory projects, the support provided by public authorities through France 2030 for the many ambitions of the Dunkirk territory will be achieved over time: these innovations will most likely inspire other industrial basins in the future.

The decarbonisation challenge, especially becoming carbon neutral, is major. The efforts and investments undertaken for the radical transformation of production methods are starting to bear fruits. Thanks to a complete decarbonisation chain, Dunkirk is aiming to reduce its industrial CO_2 emissions by 55%. As a result, Dunkirk is laying the groundwork to become carbon neutral by 2050.

Over recent years, the territory has emerged as one of the pioneers of the European industry of the future. By building a dynamic ecosystem around the transition and providing operational solutions for decarbonisation, Dunkirk is attracting new types of industries (fine chemistry, green hydrogen, electric batteries, etc.) but also future talent, those devoted to living in a territory at the epicentre of climate and ecological transition challenges.

Thus, Dunkirk and its ***"Creative Energy"*** *are role models to follow and are encouraging other industrial territories to test and share their innovations. Working together makes us undeniably stronger.*

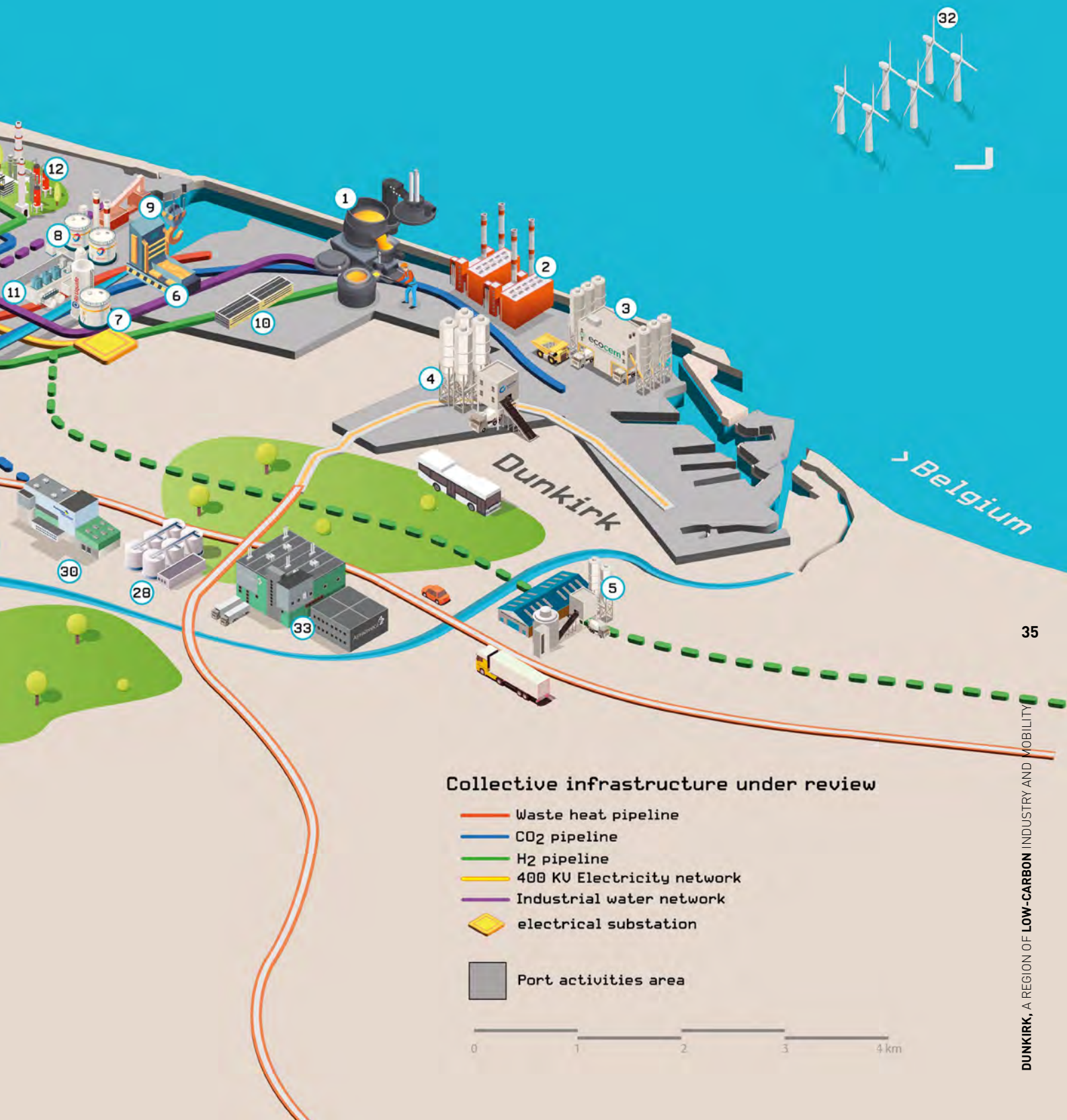
Whether it is training courses, infrastructures, public policies, Dunkirk is now, more than ever, a real laboratory for all the transitions.

DUNKIRK, CREATIVE ENERGY!

Dunkirk, a territory wit

1. ArcelorMittal Dunkerque
2. DK6 Engie
3. Ecocem
4. EQIOM
5. Borax
6. Ferroglobe
7. Air Liquide
8. Total Energies
9. Imerys Aluminates
10. Dillinger France
11. Suez
12. Eni Versalis
13. H2V59
14. ArcelorMittal Mardyck
15. Prologium
16. Verkor
17. Clarebout Potatoes
18. HSWT France
19. BASF
20. SNF Flocryl
21. Aluminium Dunkerque
22. Ameli Green Lime
23. Neomat
24. Comilog Dunkerque
25. Nuclear power plant Gravelines
26. Dunkerque LNG
27. Container terminal
28. Daudruy
29. Enchem
30. CVE
31. EDF EPR2
32. EMD-RTE
33. AstraZeneca

h a low-carbon industry



DUNKIRK IS HOME TO THE DECARBONISATION, HYDROGEN PRODUCTION AND ELECTRIC MOBILITY SECTORS

- ☑ Industrialists seeking optimal technical and economic decarbonisation solutions
- ☑ Co-product resources to be recovered
- ☑ Existing infrastructures
- ☑ Access to renewable and low carbon energy
- ☑ Proven industrial symbioses
- ☑ A dynamic and ambitious territory focussed on development around the energy transition
- ☑ A battery sector under development

écosystème D

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Conception - Création : PASQUALE COMMUNICATION – Photo credits: ÉcosystèmeD - Photothèque Air Liquide - Adrien Daste - Edition march 2025

Dunkerque Grand Littoral COMMUNAUTE URBAINE

DUNKERQUE PORT

CCHF Communauté de Communes des Hauts de Flandre

CCI LITTORAL HAUTS-DE-FRANCE