CREATION OF INNOVATION THAT BRINGS WELL-BEING

INNOVATION AND R&D

6
INNOVATION CENTERS

80
INNOVATION PROJECTS

~88
PEOPLE* INVOLVED IN R&D

30
PARTNERSHIPS FOR TECHNOLOGICAL DEVELOPMENT

* as Full Time Equivalent – FTE

PATENTS

136
FAMILY BASED

1,857
EQUIVALENTS

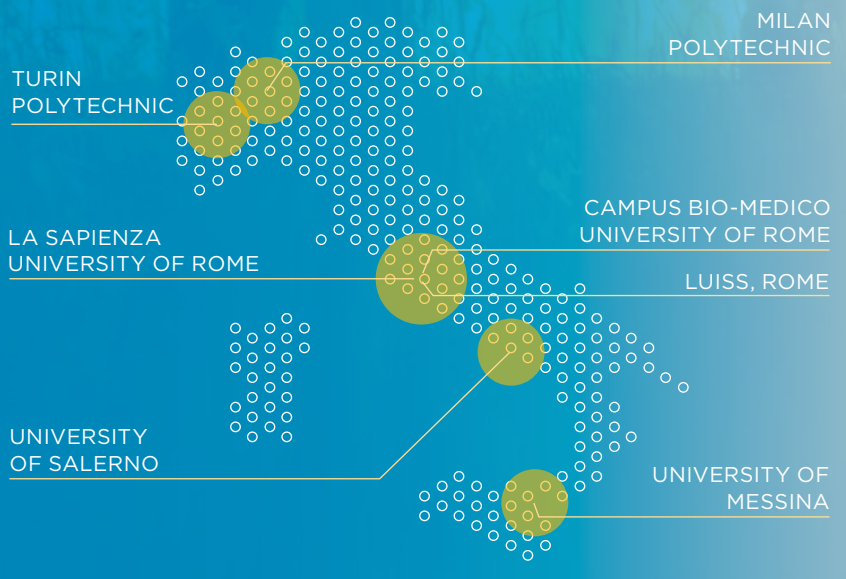
RESEARCH

13
EUROPEAN RESEARCH PROJECTS

INITIATIVES

5
OPEN INNOVATION INITIATIVES

COLLABORATIONS



ITALIAN UNIVERSITIES

4

MATERIAL TOPICS

- INNOVATION AND DIGITALIZATION

4.1 TOWARDS SUSTAINABLE, INCLUSIVE INNOVATION

In light of our journey towards 2026, we significantly boosted our efforts in research and development in 2021. Our goal is to develop and industrialise a three-pronged approach to innovation, incorporating process engineering, digitalization and EPC to increasingly support technological, industrial and social progress. This will reduce environmental impacts and contribute towards decarbonization, with innovation becoming more open and interconnected with the external ecosystem. Open Innovation, collaboration with universities, digitalization, international research projects and the growth of our patent portfolio form the foundations of our plan.

In terms of Open Innovation, we have a presence across various national and international collaboration platforms that allow us to network, discuss with other partners and examine ideas and proposals from start-ups. The Open Innovation path is one that we are also pursuing alongside several universities; with Luiss, with whom we collaborate to support a professorship in the field; with La Sapienza, with whom we have started a highly collaborative project, part of which also includes several researchers on a placement at our Rome office to work on activities related to the energy transition; with the Biomedical Campus of Rome, with whom we work in various ways, including in specific areas of open innovation. We are developing highly significant initiatives abroad, such as creating the first Indian research centre for the circular economy and recycling at NITK, an institute with whom we enjoy a very fruitful partnership, allowing us to train new generations of engineers for the energy transition.

OUR GOAL IS TO DEVELOP AND INDUSTRIALISE A THREE-PRONGED APPROACH TO INNOVATION, INCORPORATING PROCESS ENGINEERING, DIGITALIZATION AND EPC TO INCREASINGLY SUPPORT TECHNOLOGICAL, INDUSTRIAL AND SOCIAL PROGRESS.

4

In terms of digitalization, our Group is very much at the cutting edge, having initiated a series of radical changes to our organizational, engineering design and industrial infrastructure construction processes many years ago. The plants designed with this approach are intrinsically less energy-intensive and therefore have a lower carbon footprint as a result of a reduction in GHG emissions. The NextPlant digital platform aims to enable a reduction in energy consumption, especially for plants licensed by the various Group companies seeking to meet market expectations; specifically, this entails a reduction in the operating costs of industrial plants (where, naturally, the highest cost item is energy consumption) of 30% by 2030. We have numerous projects in digital-related innovation areas, as well as in technological and process-related areas. These projects will continue to grow each year, with more proprietary projects, an increase in licensing agreements and participation in multi-partner international projects.

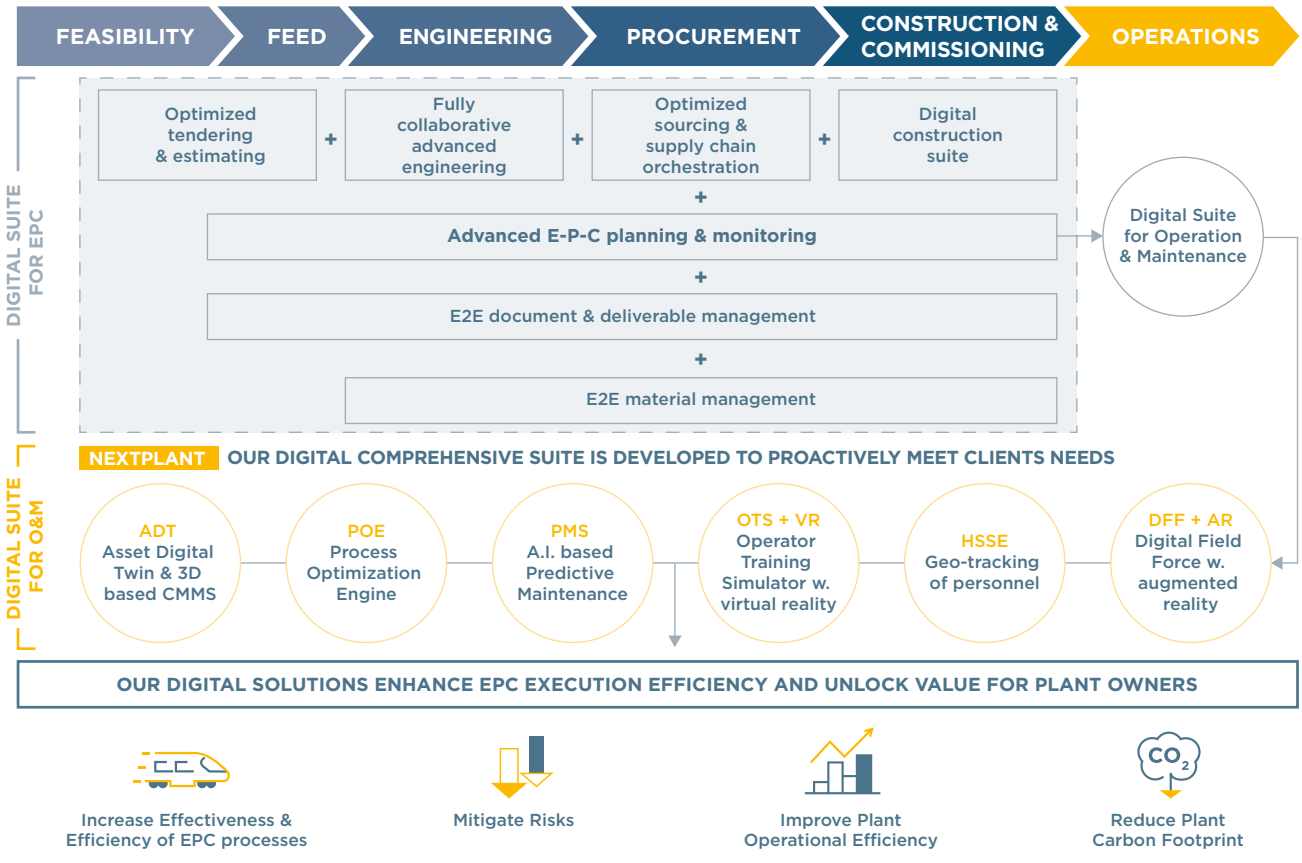
4.2 DIGITAL SUSTAINABILITY AT MAIRE TECNIMONT

Digital transformation and the energy transition are complementary and interconnected: **goals regarding the decarbonization of industrial complexes can only be effectively achieved by leveraging sustainable digitalization**.
Within an international framework that has set a target of achieving carbon neutrality by the middle of the century, new industrial plants must be designed to be intrinsically greener and be able to evolve, through a series of transitional phases, from static complexes to adaptive platforms.

Thanks to its assets, its know-how, and through responsible and sustainable action, **the Maire Tecnimont Group intends to play a leading role in contributing to the energy transition**, leveraging its portfolio, which combines initiatives related to green chemistry with digital technological solutions, to facilitate industrialization and implementation.

The digitalization process that has been underway since 2015 means the Maire Tecnimont Group has **a suite of digital solutions that work across the entire plant chain**, going from the creation (through the portfolio of EPC solutions) up to the operations phase (NextPlant). The fundamental goal of these solutions is to reduce the Total Cost of Ownership (TCO) for new and sustainable industrial complexes.

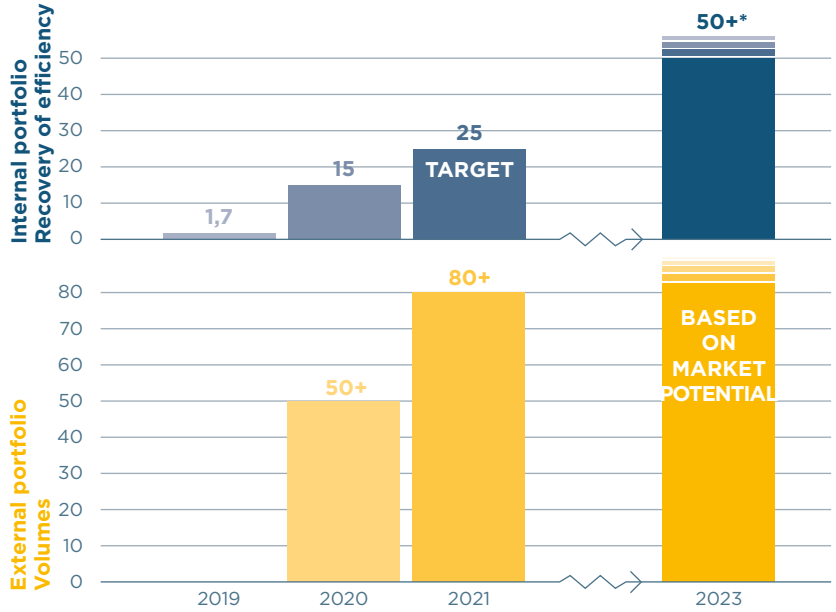
The diagram below shows the effectiveness of an integrated approach to the EPC phase and operations: in an intrinsically digitally developed plant the benefits multiply over a lifetime.
The resulting competitiveness for the contractor translates into return on investment for the plant owner but, above all, facilitates the transfer of skills and know-how from the design phase to the operation phase (with benefits locally as well) and a reduction of any gender and cultural gaps between the project's stakeholders. This leads to transparent comparison and facilitates information sharing between remote operation centres, helping to spread expertise and the potential for innovation.



The sustainable contribution from NextPlant in the operation & maintenance phase of an industrial plant is essential to minimising the environmental impact – arising from the reduction in CO_2 emissions and energy consumed – and benefiting from green incentives, which ensure that the overall supply chain has a minimal carbon footprint. Digitalised maintenance further reduces the environmental impact and minimises the possibility of torch emissions as a result of failure, leakage, accidents, or uncontrolled emissions. NextPlant can also promote greater inclusion of the various plant operators, facilitating knowledge transfer and the necessary business-aligned upskilling and reskilling, as well as enabling remote assistance from selected operation centres. The probability of human error is thus reduced and the performance of industrial plant operators maximised.

In this context the most efficient way of designing and managing these new types of plant is inextricably bound to the adoption of a broad set of digital tools, guided by business needs and leveraging asset and domain skills.

DIGITAL TOOLKIT - A LEVERAGE FOR COMPETITIVENESS



** indicated efficiency recovery is equivalent to a saving of approximately 120k man-hours on a 800M€ EPC LS project*

The discontinuity required by the energy transition also involves adapting digital technologies such as the blockchain, which, by exploiting a distributed structure, can hold critical information and guarantee transparency, integrity and inalterability. **Maire Tecnimont's vision is of the blockchain being used to certify the carbon footprint of the raw material used** (both in green chemistry processes and in the transformation of conventional hydrocarbons), ensuring access to any green benefits and demonstrating the contribution to decarbonization in terms of Scope 2-3 emissions. The use of this technology also makes it possible to certify the environmental footprint of the end products (equipping them, for example,

OUR SUITE TO ADDRESS ENERGY TRANSITION THROUGH DIGITAL TRANSFORMATION

PROCESS OPTIMIZATION FOR ENERGY EFFICIENCY & NET ZERO EMISSIONS

- Reduce CO_2 emissions
- Improve energy efficiency
- Reduce feedstocks consumption
- Blockchain for accessing to green incentives

MAINTENANCE OPTIMIZATION FOR COST EFFICIENCY

- Proactive Maintenance management
- Reduce unplanned downtime due to assets' fault
- Reduce flaring in case of faults

IMMERSIVE TRAINING FOR OPERATORS UPSKILLING / RESKILLING

- Facilitate knowledge transfer
- Effective recovery actions in case of plant upset
- Reduce unplanned downtime due to human mistakes

PROJECT CONTROL TOWER FOR PLANT MANAGEMENT DURING EPC EXECUTION

- Engineering activities status monitoring
- Materials management
- Construction activities' workfront management
- Site Quality & HSE aspect monitoring

COLLABORATIVE MODEL FOR FIELD OPERATION

- Access to data repository from field
- Cooperation with remote excellence centers

EXTENSIVE AND SAFE PLANT CONNECTIVITY

- Cost savings for conventional cables, cableways...
- Cybersafe remote control enabling
- Remote assistance enabling

ENERGY TRANSITION AND OPEX EFFICIENCY, TWO CHALLENGES ONE SOLUTION: NEXTPLANT DIGITAL SUITE

DIGITALIZATION PATH

How is Maire Tecnimont approaching the digitalization of its processes?
Maire Tecnimont has identified the key success factors involved in the practical evolution towards digitalization. Today, technology is advanced enough to develop solutions that fit the business model of the plant owner – and not vice versa. We began by transforming the most relevant processes of the EPC phases, to make them simple and adaptive. Digital transformation grants project teams immediate access to the various data sets related to the status of EPC activities. Similarly, the availability of data shared on digital platforms enables new, more advanced forms of extended organization and joint collaboration between the various operating centres and the stakeholders working on complex projects. The result is more effective execution and a reduction in workflow inefficiencies with a consequent improvement in controlling execution times, the quality of deliverables and, consequently, control of the risks involved in executing an EPC project.

Is digitalization also an advantage for clients?
This internal digitalization of work processes forms the basis of a digital portfolio, called NextPlant, aimed at making the operation & maintenance phases of industrial plants more efficient. The core objective is to design and build intrinsically more efficient, much less energy-intensive, more adaptive and interconnected industrial plants. Future plants will be hyperconnected and designed to manage transients resulting from feedstock volatility and variability. Future green chemistry plants, a natural response to the goals of the energy transition, will be smaller, more widely "distributed" and will require native digital solutions to be adopted to drive efficient management that saves on operating costs and reduces the carbon footprint in the design and operation phase.

How does digitalization fit into the energy transition?
Nextplant is designed to meet the needs of the energy transition, decarbonising processes and operations throughout the entire value chain. As a result, industrial structures will be more adaptable and sustainable in terms of total investment cost and environmental impact. Digital transformation technologies are a powerful tool that can help plant owners achieve sustainability during the current energy transition.

with eco profiles that confirm the product's actual carbon footprint, the amount of water and energy used in the production process and its origin, the presence of any recycled components in the production process and its performance, etc.), secure any incentives and give objective evidence to end consumers of the sustainability of the purchased product. The digital twin process can be used to optimise plant performance and reduce emissions, confirming the contribution to decarbonization against Scope 1 emissions.

To make green initiatives sustainable from an industrial perspective, a coordinated effort is needed, starting from the business development phase (with investor involvement) up to the completion of a project (selecting a supply chain that also has a lower carbon footprint).

As part of this profound paradigm shift, policies and legislation can facilitate a change in industry mindset and approach, guiding organizations towards increased technological innovation.

The evolution in capital allocation, from the reduction in funding for new oil production plants to incentives for new green chemistry complexes, will drastically affect the shape of the market in the future.

IT AND SUSTAINABLE EPC PROCESSES
SAP RISE – THE ERP ON CLOUD

In analysing processes based on the large-scale use of IT, the first potential conflict to be resolved is the carbon footprint of the digital infrastructure itself. According to the International Energy Agency, datacentres accounted for around 200TWh of electricity consumption in 2019, or about 1% of global energy use. However, global internet traffic increased by almost 40% in the first quarter of 2020.

Some datacentres and cloud providers are cleaner and greener than others; in any case, many of the big cloud providers are now acquiring most of their energy requirements from renewable sources. We must also remember that to cut or offset GHG emissions, it is not enough to reduce energy consumption or increase generation from renewable sources. With this in mind, some years ago Maire Tecnimont began the process of dematerialising its datacentres. This supports two aims: the digital transition (increasing system resilience and scalability) and the energy transition (choosing partners who share sustainability and decarbonization goals).

As an example, for its ERP Maire Tecnimont has chosen SAP's Private Cloud on Azure SAP RISE infrastructure.

This choice will allow the Maire Tecnimont Group to continue its digitalization roadmap and complete the migration of IT processes to the cloud, accelerating the timescales needed to achieve its strategic goals with an objective contribution to the decarbonization processes that form a part of the Group's strategic targets.

The shift to the cloud meets sustainability and scalability needs and means the Maire Tecnimont Group will be well equipped to manage every phase of future growth (from both a staff and business perspective) and will have a single technological point of contact across all areas (infrastructure, applications and cybersecurity). This initiative will contribute to achieving group targets for carbon neutrality (for Scope 1 and 2 emissions by 2030 and for Scope 3 emissions by 2050), both for Scope 2 indirect emissions, i.e. those relating to the consumption of "purchased energy", and for Scope 3, i.e. all emissions generated by the SAP partner in providing services for Maire Tecnimont.

The project, which is global in scope, will be rolled out in phases across all countries where Maire Tecnimont operates, with full migration to the cloud expected to be completed by the first quarter of 2022.

Finally, the innovative Engineering Data Management System (EDMS) platform, developed during 2021, is also part of the above strategy. The platform is aimed at enabling the transition from document management to data management. Documents transmit sensitive information which technicians must be able to access quickly to verify correctness and any changes that occurred during the development of the project. The new platform also enables workflow management, collaborative design and joint commenting functions.

CYBERSECURITY

The acceleration of the digitalization process, a feature of 2020, guaranteed operational and business continuity and confirmed the robustness of our transformation and innovation strategy, not only in terms of the complexity and size of the IT infrastructure, but also in terms of **maintaining the highest standards of IT security as an essential and integral part of our company development model. The result is that no security vulnerabilities have been found in the system.**

Through the involvement of all employees and by leveraging the advanced IT infrastructure available and mass training, it was also possible to guarantee full data protection for clients and partners. Thanks to these drivers and continuous improvement, all cases of detection and blocking of attacks and intrusions can be considered a virtuous example of the holistic approach to cybersecurity taken over this period, characterised by the greater frequency and level of sophistication of such attacks.

In 2021, the Maire Tecnimont Group renewed its ISO:27001 certification for the management of corporate information. As required by the standard, we identified the focal points for compliance and security management, which report directly to the ICT HoD.

In addition to ensuring a high level of quality in the IT security management of its IT devices, the Maire Tecnimont Group has promoted an awareness building campaign for the major industry players at an international level, including through launching simulated cyber-attack exercises (cyber contests).

The large-scale application of IoT devices that are fully interconnected via new communication protocols, such as 5G, can generate an enormous amount of data which, in turn, generates value. At the same time, this increases the potential entry points for cyber-attacks in the OT domain. To date, most cyberattacks have been focused on the IT domain before spreading to the entire corporate network; as new access points to

IMPROVEMENT ACTIONS TAKEN

8 ASSESSMENT PERFORMED:

- Azure Well-Architected Security Assessment
- Office 365 Security Optimization Assessment
- Cybersecurity Operations Service – Forensic
- External Network Penetration Test
- Internal Network Penetration Test
- Wireless Network Penetration Test
- Corporate Network Penetration Test
- Web Applications Penetration Test

USER AWARENESS:

- 10 e-learning modules embedded in a cybersecurity course delivered to the entire Company population;
- 10+ ICT communications related to ongoing threats to increase consciousness;
- 2 internal simulated phishing campaigns to test to test user behaviour and take corrective actions.

2021 FULL YEAR STATISTICS

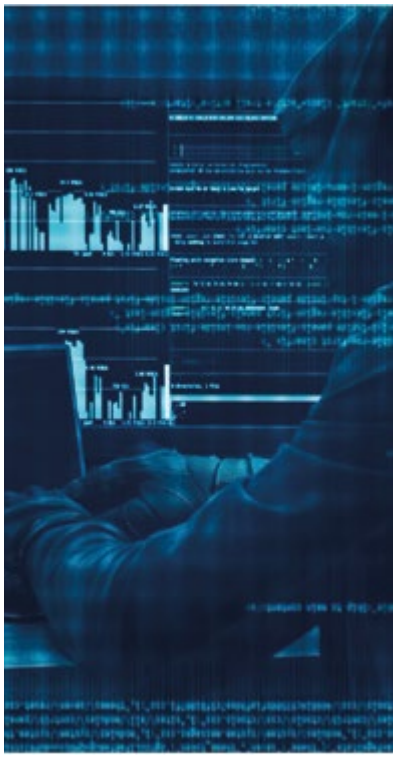
AVERAGE PHISHING EMAILS BLOCKED		3,000 PER DAY
MANAGED INCIDENTS FROM SECURITY OPERATION CENTER	EDR Incidents/DNS exploit	45 PER DAY
	Mobile Incidents	3 PER DAY
	User Anomalous Behavior	18 PER DAY
	Blocked apps	6 PER DAY
	Proactive reporting of suspicious events by users	5 PER DAY
BREACH AND ATTACK SIMULATION	Endpoint Vector Attacks	284 PER DAY
	Mail Vector Attacks	146 PER DAY
WAF – BLOCKED WEB TRAFFIC ATTACKS		262 PER DAY
THREAT INTELLIGENCE – DOMAINS, SUBNETS AND USERS ASSESSED WITH OSINT PLATFORM		250 PER MONTH
7,000	ENDPOINTS	MONITORED ON ATP
1,000	SERVICES (ONPREM, IAAS, PAAS, SAAS)	
3,500	MOBILE DEVICES	
10,000	USERS (EMPLOYEES, CONSULTANTS, B2B)	

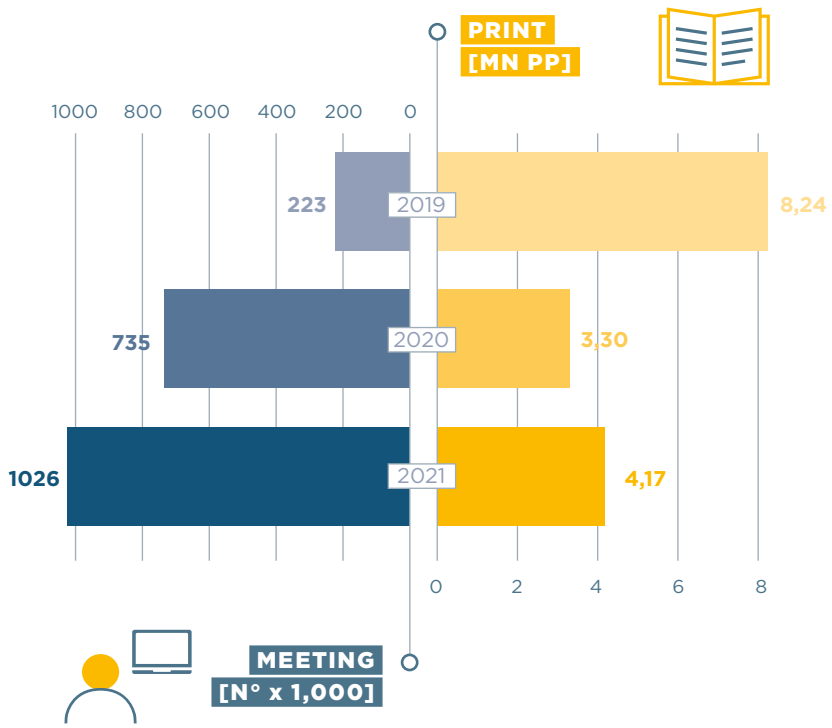
the OT domain open up, a solid cybersecurity culture is needed to avoid the risks of a cascading domino effect on business continuity.

Cyber resilience means being aware of cyber threats and ready to activate adequate protection measures for IT/OT infrastructures against increasingly sophisticated and new types of cyber-attacks, so as to minimise any potential impact on the business.

In this regard, **the holistic approach to cybersecurity – cybersecurity by design – is a fundamental asset**, involving the overall supply chain under the direction of the EPC contractor; an adaptive approach with continuous and constant focus and learning must be maintained during the entire life cycle of the plant.

The technological sustainability of any new technological district, however advanced, involves human elements and therefore requires a targeted training program to fill skills gaps and allow the organization to preserve its adaptive capacity and flexibility to successfully deal with any cyber threats.





BUSINESS CONTINUITY

The organizational model, extensive smart working, technological choices, the migration of all systems to cloud environments, the extensive use of remote collaboration tools and the advanced cybersecurity adopted to manage access to company information are all factors that continued to guarantee the full operational continuity of the Maire Tecnimont Group and its projects in 2021.

COVID-19 has had a disruptive effect on the way we work, and on the attendance of in-person meetings. From spring 2020 and throughout 2021, all operational centres were impacted by the lockdown policies adopted across countries, with an intermittent and incomplete return to normal conditions emerging only in 2021.

In the same period, the widespread use of collaborative tools continued at all group companies.

Meetings on the Maire Tecnimont Group's collaboration platform (Teams) confirmed the rising trend, already highlighted in the previous year, with average daily meetings increasing from a few hundred to over 3,000 per day. Chats and calls show similar increases.

This shows how, thanks to the choices made in recent years in relation to smart working and IT platforms, the Maire Tecnimont Group has been able to respond to several lockdowns by leveraging the new digital tools now available for our projects and operating companies.

This paradigm shift has allowed us to pursue full business continuity and maintain expected productivity even during 2021, with a doubling in hourly productivity from 2019 to 2021.

4.3 TECHNOLOGICAL INNOVATION, RESEARCH AND DEVELOPMENT

The technological advantage is a key strategic asset for the Group, whose innovation strategy is developed primarily to protect its portfolio of patents and developed technologies.

The Maire Tecnimont Group also leverages its intellectual property assets and technological expertise in order to develop new commercial projects, technology alliances and licensing.

INVESTMENT IN RESEARCH AND DEVELOPMENT

Over the last five years, Maire Tecnimont has invested around €35 million in innovation projects, including targeted investments in start-ups and partnerships, in order to create a portfolio of technologies that responds optimally to the new needs of the ongoing revolution in energy and chemistry.

NRs OF PATENTS OWNED BY THE MAIRE TECNIMONT GROUP [45]

136
FAMILY BASED

1,857
EQUIVALENTS

As of the end of 2021, the Maire Tecnimont Group owned a portfolio of more than 1,850 patents, most of which relate to urea and fertilizers.

The Maire Tecnimont Group's patents and other intellectual property rights covering the products and services it offers, including trademarks, are key assets fundamental to the Group's success and position.

As innovation is also one of the prime areas of competitive advantage for the Maire Tecnimont Group, we are continuously strengthening our R&D and our portfolio of proprietary innovative technologies in order to boost our position as a technology provider for the refining, power, oil & gas and petrochemical industries. We deliver a number of innovation projects every year and actively cooperate with leading research centres and industrial partners to continuously improve the overall performance of our technologies.

INNOVATION AND R&D

6
INNOVATION CENTERS

80
INNOVATION PROJECTS

~88
PEOPLE[46] INVOLVED IN RESEARCH, DEVELOPMENT AND INNOVATION

30
PARTNERSHIPS FOR TECHNOLOGICAL DEVELOPMENT

45 *The table lists the number of patents, including patent applications. Each patent group has different equivalents (same invention but filed in a different country).*
46 *As Full Time Equivalent – FTE.*

A BREAKTHROUGH IN INNOVATION

Antonio Batistini
Chief Technology Innovation Officer
NEXTCHEM

What is the role of innovation for NextChem and Maire Tecnimont in the energy transition?
To date, Maire Tecnimont Group has distinguished itself as an integrator of excellence in the petrochemical and fertiliser sectors, with a significant role in innovation as an EPC contractor. For some years now we have been increasingly involved in the engineering of more sustainably aligned processes. The opportunity is opening up for Maire Tecnimont Group, through NextChem, to increasingly shift profitability and returns to these segments. The goal is to become a global leader in the creation of decarbonised processes.

How are you working to accelerate this new innovation approach?
Innovation always comes from understanding what the unmet demands of the end market are. For us, it means translating these expectations into combinations of the most effective technological solutions in terms of performance and cost. We decided to upgrade our Business Development function (our interface with the market) with a Technology Development function to support the identification of all market opportunities and to create a cross-cutting R&D organization to scout globally for technologies that already exist but are still at an embryonic level, in order to identify innovative projects that can be supported through acquisitions, investments and partnerships. We want to create an organization focused on the development of specific technology platforms that will allow us to develop distinctive NextChem processes. We are talking about the development of electrochemistry (reactions that allow the reduction of CO_2 to carbon monoxide and its conversion into a reactive gas that enables the production of carbon neutral or low carbon products), the mineralization of CO_2, new technologies (pyrolysis, depolymerization) to enable the recycling of waste material that cannot be mechanically recycled. This is in addition to what we already do through MyReplast Industries in the upcycling of post-consumer plastic waste.

Getting to the end market is an ambitious goal...
We want to create unique processes that can make a significant impact on reducing GHG emissions from hard-to-abate industries and move into the production of new materials and products, from biofuels to biopolymers and circular molecules. Open innovation in the sense of openness to the world, to develop new technologies with other partners, a path in which NextChem's role is elevated from participant to coordinator and developer, with the ultimate goal of achieving ownership.

COOPERATION WITH UNIVERSITIES AND RESEARCH CENTERS

Our Group has integrated Open Innovation as a model of its innovation and research strategy. Whereas previously the "closed" model forced companies to compete only with their own resources, controlling processes for fear of ceding important information to the competition, the advent of Open Innovation overturns this approach. **It is a radical change of mindset that shifts the emphasis from controlling the innovation process to influencing it.** Within this framework, collaboration with universities makes it possible to develop and implement new technologies faster. A recent example of this approach is the collaboration between NextChem and **Sapienza University** on the "Green Chemistry and Mechatronics Open Innovation Lab" project, which involves the creation of a laboratory within the NextChem headquarters in Rome. A scientific research group from the university will work in the lab with engineers from Maire Tecnimont Group on a research project dedicated to "Waste To Chemicals".

With innovation becoming a critical factor in success, in 2019 Maire Tecnimont established a synergetic collaboration with the **LUISS Guido Carli University** by launching a professorship for Open Innovation and Sustainability, the first of its kind in Europe, and committing to the collaboration for the next eight years. Our collaboration with Luiss also includes contributing to the topic of the circular economy with lectures as part of the dedicated professorship.

A plaque at the entrance to the Chemical Engineering department of the **Polytechnic in Milan** recalls that in 1927, Montecatini (from which Tecnimont descends) was one of the first contributors to the purchase of equipment for the new laboratory. The Maire

Tecnimont Group's longstanding collaboration with the Polytechnic University of Milan has been further strengthened with partnerships for research projects, and the funding of a 15-year professorship in Chemical Engineering and Project Management, launched in 2018. We are also heavily engaged in education, specialization and career guidance.

Over recent years, the Maire Tecnimont Group has stepped up its collaboration with top Italian and foreign universities, developing research projects and exchanging views and ideas to forge a strong bridge between academia and industry.

Important collaborations are also ongoing with **La Sapienza University** in the field of energy transition technologies and socio-economic studies, and with **Campus Bio-Medico**, in the context of a master's degree course in Chemical Engineering for Sustainable Development. Other Italian academic partners include the **University of Salerno**, **University of Messina** and **Polytechnic of Turin**.

Internationally, in 2018 the Maire Tecnimont Group began working with **BHOS (Baku Higher Oil School)**, to provide concrete support for their University Master's Degree course and to supply research facilities. In India, a collaboration has been underway since 2020 with **NITK**. In March 2021, this led to the opening of an interdisciplinary research centre for waste recycling and the circular economy (the Maire Tecnimont Centre for Research on Waste Recycling and Circular Economy).

Further collaborations are ongoing with the **Eindhoven University of Technology** and with the **Ecole des Mines in Paris**.

At an international level, we also participate in the **European project EINST4INE** (The European Training Network for Industry Digital Transformation across Innovation), a network of seven international universities and 15 large companies, aimed at training expert researchers in the field of industrial digital transformation.

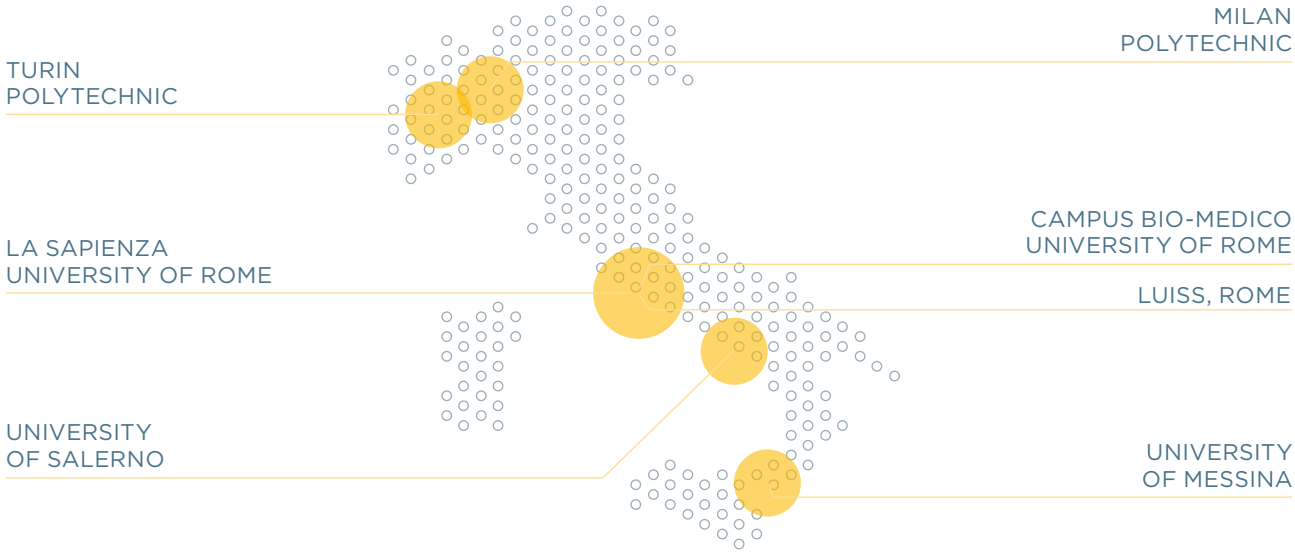
EUROPEAN UNIVERSITY

- TECHNICAL UNIVERSITY OF EINDHOVEN
- ÉCOLE DES MINES IN PARIS

INTERNATIONAL RESEARCH INSTITUTIONS

- NATIONAL INSTITUTE OF TECHNOLOGY IN KARNATAKA, INDI
- BHOS IN BAKU

ITALIAN UNIVERSITIES



BUILDING INNOVATIVE ECOSYSTEMS

Carlo Nicolais
Head of Group Institutional Relations, Communication & Sustainability
MAIRE TECNIMONT

What kind of relationship does Maire Tecnimont have with universities?
Our collaboration with universities is rooted in the mid 1900s. It has always played a strategic role in our business and takes place within a framework of exchanging ideas and knowledge which go on to influence both sides. In addition to existing longstanding relationships, such as our collaboration with the Polytechnic University of Milan, we have steadily established new connections, especially in geographies where Maire Tecnimont has a strategic presence. These bolster our technological offering for the energy transition and help knowledge sharing, especially among local businesses where the Maire Tecnimont Group operates.

What activities have been taking place recently?
Collaboration with universities is developing in a number of directions, both in Italy and abroad. One of these is related to Open Innovation and Sustainability, through the financing of the first professorship in Europe dedicated to the topic at Luiss in Rome. Open Innovation is both an internal and an external driver. In the first case, it gives a structure to the necessary interdepartmental processes for sharing knowledge. In the second, it underpins a relationship with our technology partners aimed at mutual growth. We are also developing activities with the Engineering Faculty at Sapienza University in Rome. At NextChem, we host a group of researchers working on a project to strengthen waste to chemical technologies. On the one hand, the project is looking at mechatronics, through optimising management processes and, on the other, is focusing on chemical engineering by improving the technology. Both areas involve data science and artificial intelligence activities, so that digitalization features prominently right from the development stages.

In India, meanwhile, a collaboration has been underway since 2020 with NITK. In March 2021, this led to the opening of an interdisciplinary research centre for organic waste recycling and the circular economy.

These examples show the synergy that the Maire Tecnimont Group has always sought in its relations with universities, so that the great results of the past (such as the Nobel Prize awarded to Giulio Natta for his research on polymers) are not just isolated cases, but symbolise the fruits of ongoing successful collaboration.

Professorship in Open Innovation
Luiss Guido Carli University of Rome, Italy
The Maire Tecnimont Open Innovation Chair was awarded to Professor Henry Chesbrough, Director of the Garwood Center for Corporate Innovation at the University of California at Berkeley and intellectual pioneer of the concept of "Open Innovation", which envisages a new methodology for sharing the technological expertise of several players in a supply chain, lowering barriers and thus accelerating the path to innovation. The support of our Group has enabled the launch of a strategic partnership on the themes of Open Innovation and Sustainability", which has already been successfully launched in 2019 and renewed for the next 8 years.

Green Chemistry And Mechatronics Open Innovation Project
Sapienza University
Nextchem and Sapienza University met to pool some common interests through the definition of a stable and active partnership between the Group and the University. The "Green Chemistry And Mechatronics Open Innovation" project envizages the creation of an innovative and advanced laboratory at NextChem's Rome headquarters, where a university research team and engineers made available by the Group will work. For the University, the two departments of Mechanical and Aerospace Engineering (DIMA) and the Department of Chemical, Materials and Environmental Engineering (DICMA) of Sapienza will be involved with joint scientific responsibility for the project. The focus of the research project in the first three years is Waste To Chemicals, in particular both the optimization of the waste feed phase and the study of thermodynamic reactions within the reactor.

Circular4Recovery
Campus Bio-Medico University of Rome
Participation in the Call Circular-4Recovery promoted by Campus Bio-Medico University of Rome and Marzotto Venture Accelerator with the support of other major corporations. The Call aims to select, reward and support entrepreneurial projects focussed on the development of innovative technologies, solutions and services with low environmental and social impact in the following 5 Key Focus Areas of the Circular Economy: Circular Bioeconomy; Circular Water Economy; Circular Energy Economy; New Circular Life Cycles; Circular City & Land.

Interdisciplinary Research Centre for Energy Transition in India
National Institue of Technolgy, Karnataka (NITK)
Within the partnership set up in 2020 with NITK, in March 2021, our Group launched the interdisciplinary Maire Tecnimont Centre for Research on Waste Recycling and Circular Economy. The partnership will provide 16 scholarships to students from the academic year 2021-2022 for their research and pioneering work in the field of energy transition and green chemistry. The company has already funded 2 scholarships during the 2020-2021 academic year as well as subsidised the development and construction of a pilot plant for recycling organic waste at the Institute's campus.

RESEARCH AGREEMENT WITH THE ÉCOLE DES MINES IN PARIS: JOINT INDUSTRY PROJECT (JIP): ASSESSMENT OF CRYSTALLIZATION RISK OF LNG IMPURITIES

JIP is a research project supported by the CTP laboratory of the **École des Mines** in collaboration with various industrial partners, which aims to experimentally assess the risk of crystallization of natural gas impurities during LNG production. An initial phase of the project was conducted between 2018 and 2021. Tecnimont decided to participate, together with Shell, Technip and Linde, in a second phase of the project, lasting three years, which started in 2021.

The main goal of the project is **to verify whether current specifications for LNG production are too restrictive compared to real solidification limits of the substances**. While on the one hand the risk of solidification can cause safety problems for the plants (risks of breakage, accidental gas leaks and explosions), on the other hand overly restrictive specifications require excessive gas purification, which entails higher energy consumption and higher unit costs upstream of LNG production. These include gas purification and treatment of Natural Gas Liquids, which are part of Tecnimont's core business.

By participating in this project, **new knowledge** will be acquired that will allow a **safer**, **less energy-intensive and more economical design** of plants in the natural gas and LNG supply chain, making these energy sources more sustainable.

RESEARCH AGREEMENT WITH THE ÉCOLE DES MINES IN PARIS: STUDY ON THE THERMODYNAMIC BEHAVIOUR OF NATURAL GAS IN THE PRESENCE OF CO_2

Of all fossil sources, **natural gas** has the lowest environmental impact due to its reduced carbon footprint (45% lower CO_2 emissions than coal, or 67% when pre-combustion emissions are taken into account). For this reason it has a fundamental role to play as a bridge fuel in the energy transition but, as a fossil source, there is an increasing focus on decarbonising the extraction, production and consumption cycle.
In this area, DCCD™ (Dual Column Cryogenic Distillation) technology, patented by the Maire Tecnimont Group and experimentally validated as part of a research project conducted by Tecnimont, enables natural gas to be purified in a **less energy-intensive way** compared to technologies currently available on the market; it removes CO_2 and other impurities in liquid form available for storage, instead of releasing them into the atmosphere, as in conventional processes.

In the development phase of DCCD™ technology, the **correct design of the distillation columns is based on the reliability of the calculation models** used **in the process simulation software** as opposed to the real thermodynamic properties of natural gas. An incorrect and non-optimised forecast can lead to oversized equipment, with considerable additional energy expenditure, thereby nullifying the competitive advantage of the technology.
In order to refine this knowledge, **Tecnimont** signed a Research Agreement with the "Centre Thermodynamique des Procédés" (CTP) laboratory of the **École des Mines in Paris** for **the study of the thermodynamic properties of natural gas** in the presence of CO_2 and nitrogen (the latter is also an essential component in biogas). The one-year study was concluded in December 2020 and consisted of three separate phases (see table).

	PHASE 1: THEORETICAL STUDY	PHASE 2: EXPERIMENTAL STUDY	PHASE 3: MODELING STUDY
PERFORMED ACTIVITIES	Bibliographic search of solid-liquid-vapor equilibrium data of gas mixtures	Experimental measurements of thermodynamic properties of gases in laboratory	Comparison between experimental data and data calculated by process simulators' models
MAIN OUTCOMES	Lack of data in the desired conditions	89 new experimental points measured	Re-definition of models' parameters

The results of the trial conducted by the CTP were published in 2021 in Fluid Phase Equilibria, a high impact factor scientific journal, which publishes articles related to research in the field of equilibria and transport properties of fluids, solids and interfaces.
With regard to the activities of Tecnimont's Department of Research, Innovation and Development, the results of the project enabled it to:

- carry out **further studies on energy optimization of DCCD™ technology** with new compositions of the input gas and achieve output with specifications suitable for LNG production, which requires a very low residual CO_2 content (50 parts per million).
- **create new proprietary tools integrated with process simulators**, to improve the reliability of simulator predictions in the process design phase.

The positive outcome of this project also helped drive continued collaboration between CTP and Tecnimont on another project: the Joint Industry Project.

"CO_2 TO OLEFINS" RESEARCH PROJECT: CONVERSION OF CO_2 INTO HIGH VALUE-ADDED CHEMICALS FOR CARBON VALORIZATION AND EMISSIONS REDUCTION

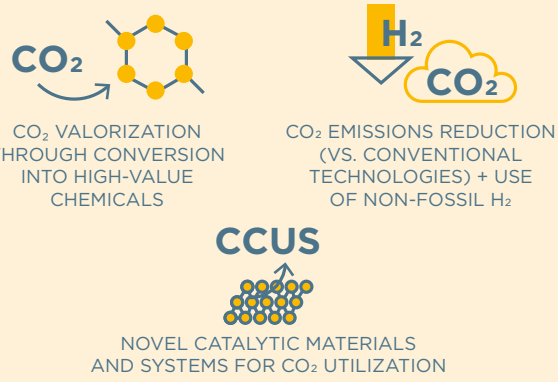
The chemical sector is the third largest emitter of CO_2, with approximately 920 million tons of CO_2 emitted in 2020. Although the demand for global chemicals is growing, a drastic cut in emissions will be needed in the coming years as part of the goal to achieve carbon neutrality by 2050.

The various emission reduction strategies include "CCUS, Carbon Capture Utilization and Storage", which not only entails CO_2 capture and storage in geological deposits, but also reuse of CO_2 through conversion to chemical compounds.

Against this background, **Tecnimont** and the **Politecnico di Milano** have begun a collaboration that aims to study a way to **convert CO_2 into high added-value chemicals**, with the dual intention of reducing the CO_2 emitted and enhancing it by giving it new life.

The specific aim of the "**CO_2 to Olefins" research project** is to develop a new catalyst and a process to convert CO_2 into olefins, which are mainly used in the production of plastics such as polyethylene and polypropylene, a sector in which Tecnimont is the market leader.

"CO_2 TO OLEFINS" VALUE PROPOSITION



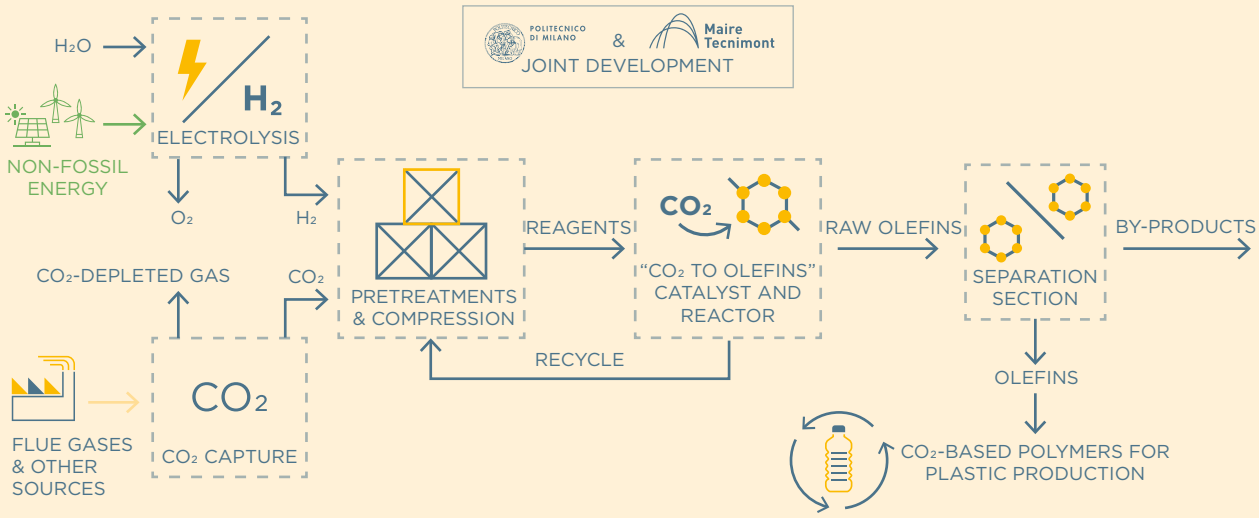
The three-year project started in November 2019. During the first year of research, an extensive **study of scientific and patent literature** made it possible to select the **most promising and innovative route** from three alternatives for converting CO_2 into olefins.

During 2021 – the second year of research – numerous **experiments** were carried out at the Politecnico's laboratories, both on the higher-performing catalytic materials identified by the previous literature review and on new materials and configurations. Tests are being conducted on all catalysts to identify the optimal **operating conditions**.

These experimental studies are supported by:

- a study of the **process scheme downstream of the catalytic reactor**, as part of a thesis being completed in partnership between Tecnimont and the Politecnico;
- **technical and environmental feasibility analyses**, which have demonstrated the sustainability of the process in terms of net emissions and avoided emissions compared to conventional technologies.

At the end of the three years of research, a decision will be taken as to whether or not to continue with the development of the catalyst and the process, possibly with the construction of a pilot plant to develop a technology capable of reducing emissions by exploiting CO_2 as an alternative source of carbon for the production of polymers.



INNOVATION IN THE FERTILIZER SECTOR

Stamicarbon, which is Maire Tecnimont Group's innovation and licensing arm, licenses technology for manufacturing urea and also provides follow-up services designed to ensure the best possible operation of a urea plant throughout its working life.

ULTRA-LOW ENERGY DESIGN

Stamicarbon's novel Ultra-Low Energy Design project is based on a truly radical innovation in energy efficiency, which leads to a reduction of about 40% reduction in the steam consumption of urea plants. This is a significant reduction in energy costs and therefore in operating expenses, and it also substantially reduces the carbon footprint compared to other types of urea plants.

MICROMIST™ VENTURI SCRUBBER

With Micromist Venturi cleaning technology, urea dust emissions of up to 10 mg/Nm^3 can be achieved. An additional Wet ElectroStatic Precipitator (WESP) can be integrated into the MMV scrubber, to reduce urea particulate emissions up to 5 mg/Nm^3. This washing technology has been combined with Stamicarbon's fluid bed urea granulation technology, which sets a new standard in urea granulation and emission control.

SUSTAINABLE PRODUCTION OF NITRATE FERTILIZERS

In a consortium led by METDEV, the project development arm of the Maire Tecnimont Group, Stamicarbon is partnering with Siemens and Sowitec (Vestas) to develop a fertilizer plant for the production of green nitrate fertilizers in Kenya. The topic has received a lot of positive responses from the industry in order to make fertilizer production sustainable.

SAFUREX®

Recycling of high-pressure equipment via a buyback programme in partnership with Sandvik, with whom we have an exclusive collaboration aimed at raising the content of recycled input material in our proprietary Safurex® material from 84% to 90%. The pilot project has been successfully completed, and the next opportunities for recycling are now being explored.

SYMBIOSIS BETWEEN STEEL AND FERTILIZERS: BASIC OXYGEN FURNACE (BOF) GAS TO UREA

In a large consortium led by Dutch Research Institute TNO, Stamicarbon, METDEV and NEXTCHEM are participating in the BOF2Urea project. The goal is to apply carbon capture and utilization (CCU) technologies in combination with carbon capture and storage (CCS) technologies based on the off-gases from steel mills, using BF or BOF gas. In this project, Stamicarbon cooperates with Arcelor Mittal. The objective is to produce ammonia/urea (in this case as AdBlue®), but the process can also be used to produce fertilizers based on recycled carbon. This is a very hot topic, as the decarbonization of the European steel industry is one of the pillars of the proposed "green deal" of the European Union.

FROM ENERGY TO FERTILIZERS

In collaboration with a number of different research institutes, Stamicarbon's R&D department is developing new advanced technologies for the sustainable production of nitrogen-based fertilizers, using renewable energy and raw materials, and with the lowest possible level of operational expenditure and investment.

SPECIAL FERTILIZERS

With the support of external partners and using the facilities of its pilot plant for fertilizer finishing technologies, Stamicarbon's strategic R&D department is developing new technologies for the production of sustainable nitrogen-based fertilizers. One technique is to add different nutrients to the fertilizer and to increase the efficient uptake of nutrients while minimising the footprint of fertilizer production and usage.

RESEARCH PROJECTS

Maire Tecnimont, through its subsidiaries NextChem, KT – Kinetics Technologies and Stamicarbon, participates in numerous research projects either as coordinator or partner. Some of these are EU funded, while others have been nationally funded.

PYROCO2

RECYCLING AND EXTRACTING VALUE FROM CO_2

The CO_2 project (Demonstrating sustainable value creation from industrial CO_2 by its thermophilic microbial conversion into acetone) aims to demonstrate the scalability and technical and economic feasibility of carbon capture and usage (CCU) to produce acetone from industrial CO_2 and green hydrogen. The heart of the technology is a biological process based on the use of high-efficiency thermophilic microorganisms. The acetone produced by the PYROCO$_2$ process will be used for the catalytic synthesis of a wide range of products, from methanol to recyclable fuels and polymeric materials. The PYROCO$_2$ demonstration plant will be able to produce at least 4000 tons of acetone per year from 9100 tons of industrial CO_2 and 1100 tons of green hydrogen. It will be located in the industrial district of Heroya Industrial Park in southern Norway. The Consortium set up for the implementation of the PYROCO$_2$ project is made up of 20 partners from 10 European countries and Thailand. It involves seven large companies (ARKEMA, FIR, SCG, JM, NEXTCHEM, CTECH), five SMEs (SC, BPT, RANIDO, HIP, ECOIN), four academic partners (CTH, DTU, Univ. Lyon1/IRCELYON/CNRS, KIT), three RTOs (SINTEF, NORCE, NORNER), one public-private cluster (AXELERA) and a public authority (VTC). *Grant agreement No. 101037009.*

prometeo

GREEN HYDROGEN PRODUCTION

The H2020 PROMETEO project (Hydrog en production by means of solar heat and power in high temperature solid oxide electrolysers) aims to develop a technology for the production of hydrogen from renewable energy through a process of solid oxide electrolysis. The technology will be demonstrated through the creation of a prototype 25 kWe solid oxide electrolyser capable of producing 15 kg of hydrogen per day; the modular-design system can be replicated on an industrial scale potentially in the order of MWe. The prototype will be integrated with a coupled with a storage system that will optimise the use of (intermittent) solar energy for hydrogen production. The Consortium set up for the implementation of the project involves eight European partners: ENEA (coordinator), Fondazione Bruno Kessler, Capital Energy, Solid Power, Institutos Madrileno de Estudio Avanzados, SNAM, École Polytechnique Fédérale de Lausanne, Stamicarbon and NextChem. *Grant agreement No. 101007194.*

INITIATE

RECYCLING AND EXTRACTING VALUE FROM CO_2

The H2020 project INITIATE (Innovative industrial transformation of the steel and chemical industries of Europe) involves major industrial players from the steel, fertilizer and energy transition industries (Arcelor Mittal, SSAB, **Stamicarbon**, **NextChem**), functional material suppliers (Johnson Matthey and Kisuma Chemicals), multidisciplinary research centres (TNO, SWERIM, POLIMI and Radboud University) and experts in the publicising circular-economy issues (CO_2 Value Europe). With the INITIATE circular economy project, the carbon and energy contained in the gases emitted by steelmaking processes become raw material used in the production of urea, which is the basis for the production of fertilizers and other products. The project will demonstrate a reduction of 30% in primary energy intensity, of 95% in the carbon footprint, of 40% in raw material intensity and of 90% in waste production. INITIATE will validate the proposed technologies on a pilot scale in a real industrial environment (TRL7) by producing NH3 from the residual gases of steel production, through three experimental test campaigns lasting six weeks each. *Grant agreement No. 958318.*

DECADE

RECYCLING AND EXTRACTING VALUE FROM CO_2 AND IMPLEMENTATION OF SOLAR ENERGY IN PROCESSES

The H2020 project DECADE (DistributEd Chemicals And fuels production from CO_2 in photoelectrocatalytic Devices) proposes a new photoelectrocatalytic (PEC) approach for the conversion of CO_2 to overcome the limitations of current PEC systems and to maximise the effective use of solar energy. Bioethanol and waste CO_2 are used to produce a mixture of high value-added products (ethyl acetate and ethyl formate in ethanol), to be used as a green solvent or as a performance-enhancing component for biofuels. The application of this technology on flue gas (containing CO_2) from methanol production plants will also be analysed, in order to produce compounds with higher added value, reduce the overall carbon footprint from methanol production, valorise waste CO_2 and introduce renewable energy into the production chain. The consortium comprises 14 European partners: European Research Institute of Catalysis A.I.S.B.L. (Coordinator), Interuniversity Consortium for Materials Science and Technology, Fundacio Privada Institut Catala D'Investigacio Química, MAX-PLANCK-Gesellschaft Zur Forderung Der Wissenschaften EV, Asociacion Centro de Investigacion Cooperativa en Biomateriales - CICbiomagune, Forschungszentrum Jülich GMBH, **NextChem**, HYSYTECH, EKODENGE Muhendislik Mimarlik Danismanlik Ticaret Anonim Sirketi, UNISMART Padova Enterprise, Motor Oil Hellas Diilistiria Korinthou AE, MERIT Consulting House, FILA Industria Chimica, CASALE SA, and 1 international partner: the University of Tokyo. *Grant agreement No. 862030.*

CHEMICAL RECYCLING OF PLASTICS

The H2020 project DEMETO (Modular, scalable and high-performance DE-polymerization by MicrowavE TechnolOgy), which concluded in 2021, aimed at the industrial-scale chemical recycling of PET-based waste by intensifying the alkaline hydrolysis reaction with microwaves. NextChem is involved in the design and construction of a demonstration plant capable of processing 500 kg/day of PET flakes obtained from mechanical recycling, and of producing ultra-pure monomers that can be reintroduced into the production of new "virgin" PET. The consortium running the project consists of 14 European partners from the entire PET value chain (**NextChem** (Coordinator), 3V Tech, ACTOR Technical University of Denmark, The European Outdoor Group, EuPC, The Fricke and Mallah GmbH, GR3N, H&M Nennes & Mauritz AB, NEOGROUP, RECUPRENDA, PETCIA, SUPSI and Synesis). The project is also being monitored by an Industrial Advisory Board whose members include Coca-Cola, Adidas, Nike, Oviesse, Danone and Unilever, among others, who are committed to researching recycling technologies for their materials of interest. *Grant agreement No. 768573.*

IMPLEMENTATION OF SOLAR ENERGY IN PROCESSES

The H2020 project PEGASUS (Renewable Power generation by solar Particle Receiver Driven Sulphur Storage Cycle), which concluded in 2021, aimed to investigate a new cycle for renewable electricity generation that integrates an innovative solar technology, based on a solid particle centrifugal solar receiver, and a sulphur thermochemical cycle. The passage of sulphur through its various oxidation states allows excess solar thermal energy to be stored in the form of chemical energy through elemental solid sulphur. Unlike conventional storage based on high-temperature fluids such as diathermic oil or molten salts, this particular type of storage is long term, as it is achieved from a compound that is stable at room temperature, and which as such is not subject to degradation through thermal dissipation. Through combustion within a power generation cycle, solid sulphur releases the stored chemical energy as heat, and re-enters the thermochemical cycle. The project is run by a consortium consisting of DLR as coordinator, **NextChem**, APTL/CERTH, the Karlsruhe Institute of Technology (KIT) and BrightSource (BRS). *Grant agreement No. 727540.*

VALORIZATION OF WASTE STREAMS AND USE OF ALGAL BIOMASS

MEWLIFE MEWLIFE (MicroalgaE biomass from phototrophic-heterotrophic cultivation using olive oil Wastewater) aims to demonstrate the environmental benefits and economic feasibility of an innovative system of algal biomass cultivation through an integrated phototrophic-heterotrophic cultivation system. The specific objective is the re-use and valorization of waste water used in olive oil production as a source of carbon for microalgae growth. The compounds (starch and carotenoids) accumulated in the algal biomass will be extracted and tested for the production of biopolymers and for use in nutraceutics. The consortium includes 6 partners: **NextChem** – coordinator, BIO-P (joined NextChem in 2021), Labor, High Tech Recycling (HTR), Technosind, Megara Resins. *Grant agreement: LIFE17 ENV IT000180 – MEWLIFE.*

IMPLEMENTATION OF SOLAR ENERGY IN PROCESSES

The H2020 project HIFLEX (HIgh storage density solar power plant for FLEXible energy systems) aims to demonstrate, on an industrial scale, an innovative technology in the field of concentrated solar power, based on a solid particle centrifugal receiver. The use of a solid that can reach temperatures of around 1000 °C as a heat carrier and storage medium enables electricity to be produced by means of highly efficient thermodynamic cycles. The project includes among others **NextChem** and **KT-Kinetics Technology** as coordinators, Barilla, DLR, John Cockerill, SUGIMAT, HelioHeat GmbH, Tekfen, Dürmeier and Quantis. The objective is the design, construction and commissioning of a semi-industrial plant within a Barilla production facility. The collected solar energy will be used in the pasta production cycles on the site. This project is the only one of its kind. *Grant agreement No. 857768.*

SYNGASES/CHEMICAL INTERMEDIATES

The H2020 project BIZEOLCAT (Bifunctional zeolite based catalysts and innovative process for sustainable hydrocarbon transformation) is being run by a consortium of 14 partners: Fundacio EURECAT (project coordinator), NextChem, Universitetet I Oslo, Technische Universiteit Eindhoven, Sintef AS, Centre National De La Recherche Scientifique – CNRS, Kemijski Institut, Turkiye Petrol Rafinerileri Anonim Sirketi, Perstorp AB, Strane Innovation SAS, European Research Institute Of Catalysis, A.I.S.B.L., Asociacion Española De Normalizacion, and CEPSA. BIZEOLCAT addresses the need to reduce the carbon footprint of the refining sector by developing innovative catalysts and process models for the conversion of light hydrocarbons (C1, C3 and C4) into light olefins and aromatic compounds. *Grant agreement No. 958318.*

CAPTURING CO_2

MEMBER (advanced MEMBranes and membrane assisted procEsses for pre- and post-combustion CO_2 captuRe) includes a consortium of 17 partners, with Tecnalia as project coordinator. The main objective of the MEMBER project is to demonstrate the application of advanced materials and innovative technologies based on membrane separation to pre- and post-combustion CO_2 capture processes for power plants and hydrogen production coupled with CO_2 capture. Three prototypes will be designed and tested during the course of the project. The project received funding from the European Union's Horizon 2020 research and innovation programme. *Grant Agreement No. 760944.*

HYDROGEN PRODUCTION

The R&D project PROMECA (PROcess intensification through the development of innovative MEmbranes and CAtalysts) involves a consortium of 6 partners, with the University of Salerno as project coordinator. The project's strategic objective is to make a substantial contribution to empowering the knowledge, skills and competitiveness of European research by implementing a research programme and seconding researchers to academic and industrial partners in Europe; this will make a significant contribution to Europe's existing trend in innovation. The technological topic of interest is the distributed production of hydrogen from renewable charges, through the innovative technology of catalytic membrane reactors. The project received funding from the European Union through the Marie Skłodowska-Curie and Innovation Staff Exchange (RISE). *Grant Agreement No. 734561.*

PRODUCTION OF CHEMICALS

The MACBETH (Membranes And Catalysts Beyond Economic and Technological Hurdles) project aims to demonstrate membrane catalytic reactor technology at an industrial level. The project, coordinated by Evonik, brings together the skills of 24 partners working in selected teams across four lines of technological development who will also engage in simultaneous cross-fertilization activities to identify further ideas for innovation. The project's large consortium can draw on a wide range of technological expertise in the fields of catalysis, membranes, media, reactors, engineering and modelling, and the members also include several end users of the proposed technologies. Sustainability is the key driver of the project, as the new technology aims to significantly reduce GHG emissions by more than 20%, with a simultaneous 20% increase in energy efficiency. The project received funding from the European Union's Horizon 2020 research and innovation programme. *Grant Agreement No. 869896.*

SAVING ENERGY AND REDUCING EMISSIONS OF CO_2

The LIFE SUGAR (SUstainable Glass: Architecture of a furnace heat recovery system including a steam Reformer) project involves a consortium of 5 partners, with Stara Glass as project coordinator. The aim of the project is to **provide the glass industry with a new technology to reduce energy consumption and CO_2 emissions during the melting process**, by integrating a steam reforming unit into the plant model. The concept will be demonstrated through the design, construction and testing of an innovative steam reformer pilot unit, which will be installed in an industrial environment. The project received funding from the European Union's Horizon 001314 research and innovation programme. *LIFE19 CCM/IT/001314.*

4.4 OPEN INNOVATION

We live in a very fluid, dynamic world, where change is uneven, sudden and difficult to manage. In this context, companies from all over the world – of any size and production sector – are facing a profound transformation of their business model, which must shift from an innovation model based mainly on internal R&D activities ("Closed Innovation"), to a constant and synergistic dialogue with the outside world ("Open Innovation"). They must, therefore, make their important contribution in the SDGs era by identifying new responsible business models, investments, innovation and technological development, and by activating multi-stakeholder collaborations.

Sustainability issues are increasingly becoming a vitally important part of corporate strategy. Even more so than in the past, this is taking on a fundamental role in the transformation, development and innovation of companies whose effectiveness, in terms of implementation, is largely represented by their ability to manage innovation in its broadest sense: Open Innovation. These capabilities are thus crucial in supporting the achievement of strategic objectives, and consequently of the expected business benefits. They will contribute to the process of change and transformation of the company over time. **Open "green" innovation, which means the right combination of innovation (product, service or process) and sustainability, is the key to tackling this profound transformation**, in which innovative technologies will be used in order to develop new sustainable solutions in line with the SDGs. Clearly, if a company is to take a decisive stance on the environmental and social impact of its business, this attention must be extended to all the partners in its value chain.

Open Innovation therefore represents a **new cultural and strategic approach**, whereby in order to create value and to compete in the marketplace, companies are also choosing to make use of solutions, tools and technological expertise from the outside. The definition of an Open Innovation management strategy therefore becomes a critical factor for success. Another such factor is the implementation process, which depends on its alignment with the corporate vision, so that the process is firstly accepted at management level and then at all levels of the wider corporate culture.

In a context in which innovation has become a critical factor for success, the adoption of open systems of collaboration with a range of players allows us to pool resources and skills in order to develop new solutions.

Maire Tecnimont sees the adoption of an Open Innovation model as a strategic need. Such a model must not seek to wall in the innovation process, but instead must open it up to collaboration across a wide network of players: exploiting external resources, developing new products and generating new ideas and sources of income for the Group and the system. To this end, **the Maire Tecnimont Group has adopted some Open Innovation practices** to accompany the process of transformation which is now underway in relation to Open Innovation and related issues, in order to promote and spread the culture of Open Innovation, to establish a presence in innovation environments, to coordinate the Group's internal and external Open Innovation initiatives, and to enable the innovation ecosystem.

INITIATIVES

During the year we consolidated some initiatives (continuing the work started in 2020) and started new strategic collaborations with a view to enabling the Open Green Innovation model.

The main initiatives are as follows:

MIND
MILANO INNOVATION DISTRICT

FEDERATED INNOVATION @MIND

The GreenTech & Sustainability thematic area launched together with A2A, ENELX and ENI. During the year we drew up and published the Innovation Agenda, a document that contains the strategic guidelines and objectives of the thematic area for the next 2 years.
MIND brings together national and international excellence in scientific, technological and digital experimentation. The companies will experiment with technological, scientific and digital innovation projects using the "Federated Innovation Model", an innovative and collaborative methodology that combines Open Innovation with the more traditional business model.
The aim is for the Group to make an active contribution to the project by offering on the one hand a technological platform to facilitate the industrialization of solutions of interest, and on the other, to offer our commercial platform to facilitate the international dissemination of these solutions.

Within the Thematic Area "Greentech & Circular Economy", the main strategic domains of interest were drawn up during the year by the founders:

- **Cross Greentech:** reduction or elimination of carbon dioxide (CO_2) from energy sources, in order to avoid (reduce) greenhouse gas emissions and the management of innovative hard-tech solutions
- **Energy Transition (ET):** the global energy sector's shift from fossil-based energy production and consumption systems (including oil, natural gas and coal) to renewable energy sources such as wind and solar
- **Air and Water (AW):** refers to the quality and availability of atmospheric air and the quality of freshwater and saltwater basins on Earth, with particular focus on populated areas
- **Circular Economy (CE):** economic model based on sharing, renting, reusing, repairing, renovating and recycling, in an (almost) closed circuit, where the products and materials contained in them are highly prized. In practice, it involves minimizing waste.

OPENITALY
elis

OPEN ITALY (ELIS)

This is the innovation ecosystem created within the Elis Consortium. The aim of OPEN ITALY is to foster dialogue and collaboration between large enterprises, Italian start-ups/SMEs and innovation enablers such as accelerators, research centres, venture capitalists and young talents.
The latest edition, in 2021, was held with the involvement of more than 50 large corporates, with 374 startup candidates and almost 2000 solutions put forward to meet companies' challenges.
In connection with OPEN ITALY, Maire Tecnimont is an industrial enabler of green technologies thanks to the expertise provided by NextChem, and is contributing to the growth of this ecosystem thanks to the strength of our Group. Our participation in the initiative allows us to develop a dealflow of solutions that represent opportunities for the development of green projects.

ZERO

Is the Italian Cleantech Accelerator of the National Network of Cassa Depositi e Prestiti (CDP) Accelerators, launched by CDP Venture Capital SGR - Fondo Nazionale Innovazione, Eni, LVenture Group and ELIS, with the support of the Corporate Partners Acea, Maire Tecnimont and Microsoft. ZERO was created to identify startups with major business potential and a zero-impact solution for the environment. The Road to Zero agreed around the world aims to achieve carbon neutrality by 2050. All the technologies, products and services that contribute to the protection and maintenance of natural resources can play a part in achieving this objective.
For Maire Tecnimont, initiatives like this are ideal contexts in which to strengthen or develop new partnerships, in full awareness of the tangible and intangible benefits that open innovation can offer both inside and outside the Group.
The verticals covered by the programme are perfectly in line with the strategic objectives of the Group and the United Nations SDGs, as the main promoter of the programme is a leading Italian institution and the partners involved are top Italian companies.

CALL4RECOVERY

Is a call promoted by Università Campus Bio-Medico in Rome and Marzotto Venture Accelerator, with the support of Enel and the partnership of Maire Tecnimont as well as other major corporates. It aims to find technological solutions in the field of energy transition and sustainability in line with the challenges set out in its 5 Key Focus Areas (Circular Bioeconomy, Circular Water Economy, Circular Energy Economy, New Circular Life Cycles, Circular City & Land).
For Maire Tecnimont, acceleration programmes are open-innovation initiatives that promote the cross-fertilization and discussion of ideas, leading to the identification of new business opportunities.
At the moment, the Group is actively evaluating interesting solutions in order to select those that will be invited to join the Acceleration Programme.

BELUGA

Caracol and Nextchem (Maire Tecnimont Group) have created Beluga, a joint research project to create the world's first prototype of a 3D printed monocoque sailboat with MyReplast™ recycled input material. A symbol of new beginnings, departures and exploration – and on this occasion also of a renewal for the world of manufacturing – the boat was presented at the 2021 edition of the Milan Fuorisalone.
MyReplast technology combines innovative optical separation techniques with extruder formulation processing, making the process a true example of upcycling. Contaminated, low-value mixed polyolefin waste is therefore brought back to a level of purity and quality that allows it to be transformed and made into new objects, replacing virgin polymers.
Plastics and circular economy processes that make it possible to give new life to waste materials are the central points of the installation, highlighting their potential for both design applications and the industrial world. MyRelast™ is an example of how recycled input materials can be successfully used for the production of advanced components that have high performance requirements.
Open Innovation projects like this leverage the Group's resources to find the best external partners for innovation projects that will add the greatest value to internal skillsets.