# iNDUSTRIAL PLANTS

May 2019

ITALIAN ENGINEERING, CONTRACTING AND PLANT COMPONENTS SUPPLIERS

ANIMP

ITALIAN ASSOCIATION OF INDUSTRIAL PLANT ENGINEERING

Special issue of "**IMPIANTISTICA ITALIANA**" Official magazine of **ANIMP** Italian Association of Industrial Plant Engineering

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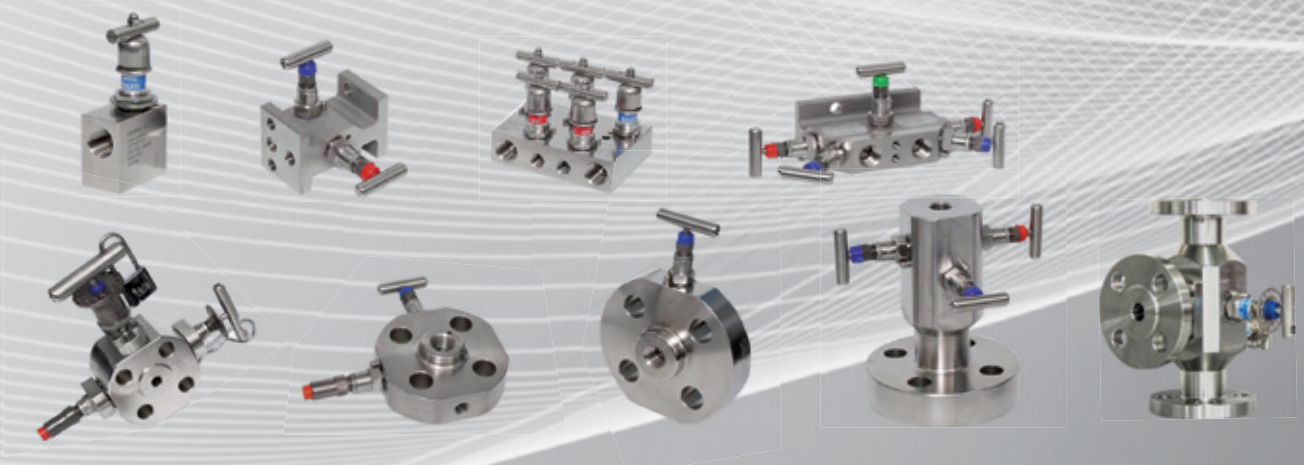

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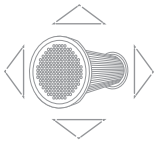

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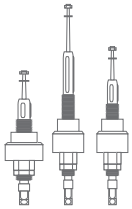

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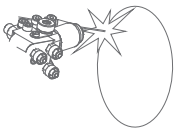

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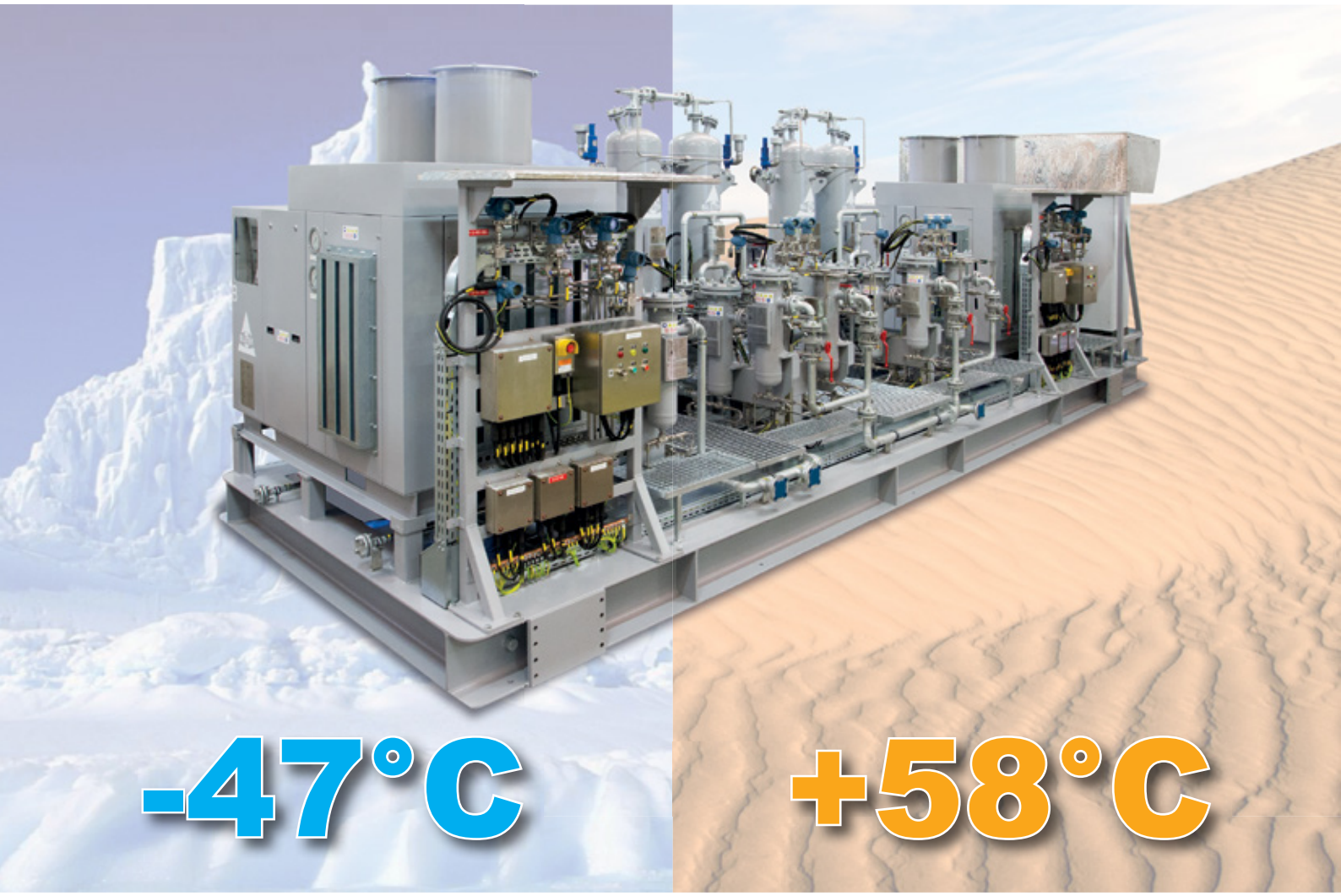




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# Editorial

# Developing integrated networks of Companies to meet new challenges in world markets

**Antonio Careddu**
**ANIMP President**
*Head of Onshore Business Development, Commercial and Tendering*
*Saipem SpA*

I am pleased to introduce also this year *Industrial Plants*, ANIMP's yearly publication for international audiences, which highlights a selection of our industry's recently completed projects or of those under execution, both in international and domestic markets.

The promotion of growth, development, innovation and international cooperation are the main goals of ANIMP, the Italian Association of Industrial Plant Engineering Companies, which includes engineering firms and general contractors, plant component manufacturers, service suppliers as well as universities, with the main focus on designing and building large industrial plants in every corner of the world. With its more than 500 current members, for over 45 years ANIMP has strived to develop a world-class supply chain, competitive globally in any industrial plant market.

Our industry is coming back after several very difficult years with big upheavals. Since 2014, the oil and generally energy prices have been low for a long time. Consequently the investments in the oil & gas industry have been halved, creating havoc in the supply chain. Our end users have asked the EPIC general contractors to reduce their prices significantly, often by 50% or more. In turn, the EPIC general contractors have tried to pass on these requests onto their supply chain. Many companies have disappeared, others have been the target of significant M&A activities. The best companies, the ones who have survived the crisis, have turned themselves around and have become much more competitive. Today, the Italian companies compete on a par again with all worldwide suppliers, even with the Asian ones.

**ANIMP is the right context in which to develop further our enterprises, by emphasizing a network approach**

But how long will this market comeback last? Over the next years we do see a gradual and cautious return to investments in the oil&gas industry, but in the medium and long term also significant 'transitions' into the utilization of different non-carbon based energy forms - a significantly bigger role of electric power and an ever

more decisive shift to renewable energy sources, just to name a few. This will require a substantial industrial repositioning of our plant industry and a realignment of our supply chains. ANIMP is the right context in which to continue developing our enterprises by emphasizing a network approach:

- By fostering cooperation and by putting together the technical and human resources and experiences among all our players, from the suppliers to universities, in order to satisfy the Clients' future needs;
- By pooling the financial resources, for example, via CDP – *Cassa Depositi e Prestiti,* the national institution which has supported the Italian economy since 1850 as the financier of public investment, supporter of international cooperation and catalyst for the country's infrastructure growth, through its many Companies, such as SACE SIMEST, which offers a wide range of financial and insurance products and services to support the Italian businesses;
- To bridge the cultural gaps, which are always so numerous;
- To develop and improve technologies and manufacturing techniques, in order to allow production also outside the traditional 'manufacturing districts' typically connected to a specific historic territory.

This network integration is the main objective which the ANIMP association is following today, in order to provide added value to our Associates, where each member Company will continue to work independently, but will be able to pool the resources where appropriate, without the need to duplicate them.

Such an approach is essential, since the boundaries between various activities in the energy fields are collapsing, and we all need to reposition our outlooks in ways that nobody had imagined even a few years ago.

We therefore look into the future with renewed optimism, ready for new challenges. We also remain grateful to the Italian industry for their strong and continuing support to ANIMP.

Antonio Careddu

## Antonio Careddu

Antonio Careddu graduated at Politecnico di Milano University and joined Saipem as an electrical engineer.

From 1991 to 1998 he was assigned various roles in Saudi Arabia, Mexico, Malaysia, Republic of South Korea, Oman. In 1999 he came back to Italy to take the responsibility as Department Manager and later as Project Director.

In 2010 he became Country Manager and CEO of Saipem Contracting Algérie and in 2012 Chairman and CEO of Saipem France.

In 2013 he returned to Italy and was appointed Director of the Saipem's Innovation, Systems and Corporate Marketing Unit.

In August 2018 he was appointed Head of Onshore Business Development, Commercial and Tendering.

ANIMP President since mid-2018

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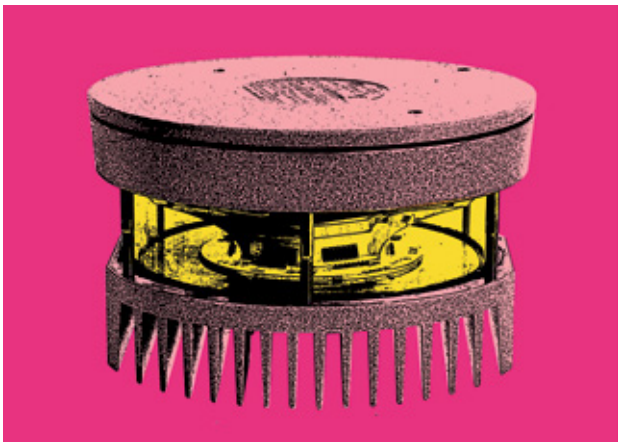
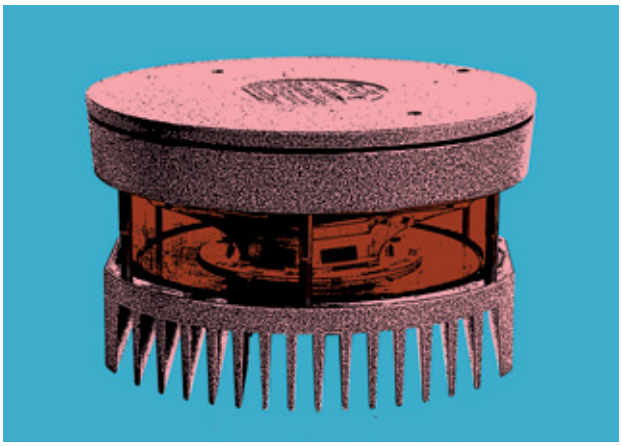
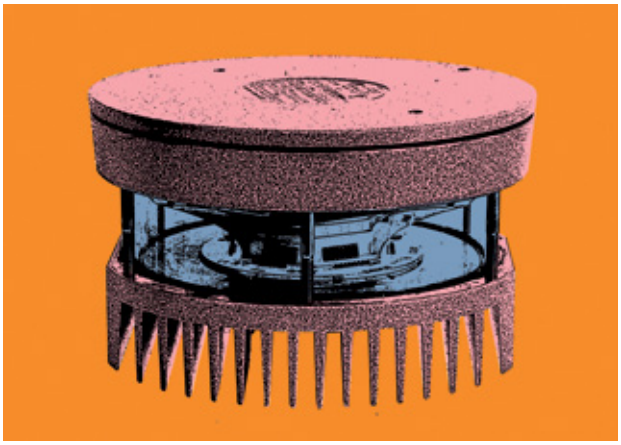
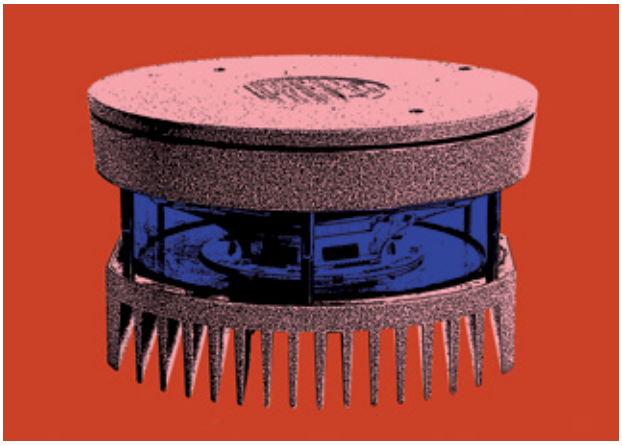

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# “Your Sustainable Choice” Project

The Rosetti Marino Group of Companies has put in practice comprehensive Sustainability Project since 2016

**Aldo Scopetti,** HSSE-Q Manager
**Alessandro Pedini,** Communications Specialist and Sustainability Project Manager,
Rosetti Marino

The concept of sustainable development was introduced in 1987 by the Bruntland Commission as the ability to cope with the needs of the present without compromising the ability of future generations to satisfy their needs.

This concept is often mistakenly interpreted exclusively in its environmental sense with all the attention totally focused on the protection of the ecosystem and the use (or abuse) of environmental resources.

Rather, sustainability is a much broader concept, which should be understood as the capacity of a business to maintain a balance over time (i.e. to sustain) between economic prosperity, the company's focus on its stakeholders (internal and external), and the sound management and preservation of environmental resources.

Sustainability is therefore made up of three components: financial, social and environmental aspects.

This concept must necessarily become part of the business model, because it is not just about the use of material resources and sources of energy but also about the ability to remain competitive in the market, the safeguarding of health and safety at work, the quality of life in the work environment, the elimination of any sexual, ethnic or religious discrimination, and respect for and development of the social well-being of the communities and areas in which the Enterprises are operating.

## Sustainability as an Enterprise value

Sustainability takes on distinctiveness and competitiveness only if it is actually integrated into the business processes and the company's value chain.

Otherwise we run the risk of limiting it to a "greenwashing" exercise.

As the commitment to the issues of sustainability increases, the company structure tends to grow and to innovate at the same rate. In particular, the development of a culture of sustainability can bring important and significant benefits, including:

- regulatory compliance and the development of integrated and advanced policies;
- the voluntary adoption in the market of practices of sustainability and standards that are highly visible and distinctive with recognition from clients;
- efficiency in the use of materials and energy resources, in production processes, and in staffing structures;
- improvement in the management of environmental impacts, waste management and recycling;
- optimisation of logistics;
- product innovation;
- improvement in the company's working environment and employee relations;
- improvement in relations with the local community.

Management systems are evolving from systemic models based on established procedures to behavioral models based on leadership, on adaptability to the context, on the ability to manage risks and pportunities and on cultural development.

The sustainability culture is part of this concept.

Communication is a key element in the development of the culture of sustainability both for the running of the business and for the improvement of environment and community.

Top Managers and Company leaders are cascading goals, mission and model on how-to run a sustainable business. To "engage" people we need to inform and communicate goals and values in a clear and effective way, and to act management by examples.

## Sustainability increases the company's ability to foster, develop and control innovation

Sustainability increases the company's ability to develop and control innovation. This is a key factor in a market increasingly characterized by competition and by management of change.


*Map of Key issue areas for Oil and Gas SGDs: taken from the UNDP, IFC, IPIECA Report named "MAPPING THE OIL AND GAS INDUSTRY TO THE SUSTAINABLE DEVELOPMENT GOALS: AN ATLAS"*

## 2030 Agenda: 17 Sustainable Development Goals

On September 25, 2015, the United Nations General Assembly adopted the 2030 Agenda for the Sustainable Development.

17 Sustainable Development Goals (SDGs) have been deployed in the Agenda to address some of the most significant economic, social and environmental challenges.

This represents the world's plan of action for overcoming poverty while protecting the planet and ensuring welfare and prosperity.

Each UN member government is expected to use the SDGs to set its own agenda and national plan, nevertheless it is a matter of fact that the private industrial sector shall play an important part in contributing to their achievement.

All stakeholders—governments, private sector, civil society and citizens alike—need to be constructively engaged to achieve the SDGs.

The Energy sector with its industrial related activities is crucial to the global economy.

In particular, Oil&Gas sector, too often identified as the "evil" when compared to the renewable energies, is still critical for many national economies, especially for the development of many emerging countries.

This sector is also central to the overall sustainable development, as fossil fuels are key pillars of the global energy system and, as such, are drivers of economic and social development.

In particular for our Country, in Italy, the process of transition to the renewable energies cannot be regardless about the use of a strategic resource such as the natural gas.

As an EPC contractor for the Energy industry, our challenge is to identify the linkages between our model of business and the relevant SDGs, understanding how to pursue the applicable ones into our operations to make an important contributions to the Sustainable Development.

**As an EPC contractor in the Energy industry, our challenge is to identify the linkages between our model of business and the relevant Sustainable Development Goals**

Taking action on the selected SDGs is an important opportunity for our companies for leading to greater efficiencies, cost savings and competitiveness, and enhance our reputation and relationship with the Stakeholders.

## "Your Sustainable Choice" Project

Our Sustainability Project started by the end of 2016; it involves the Italian companies of our Group (Rosetti Marino, Fores, Basis and, starting from 2018, Tecon and Rosetti Superyachts).

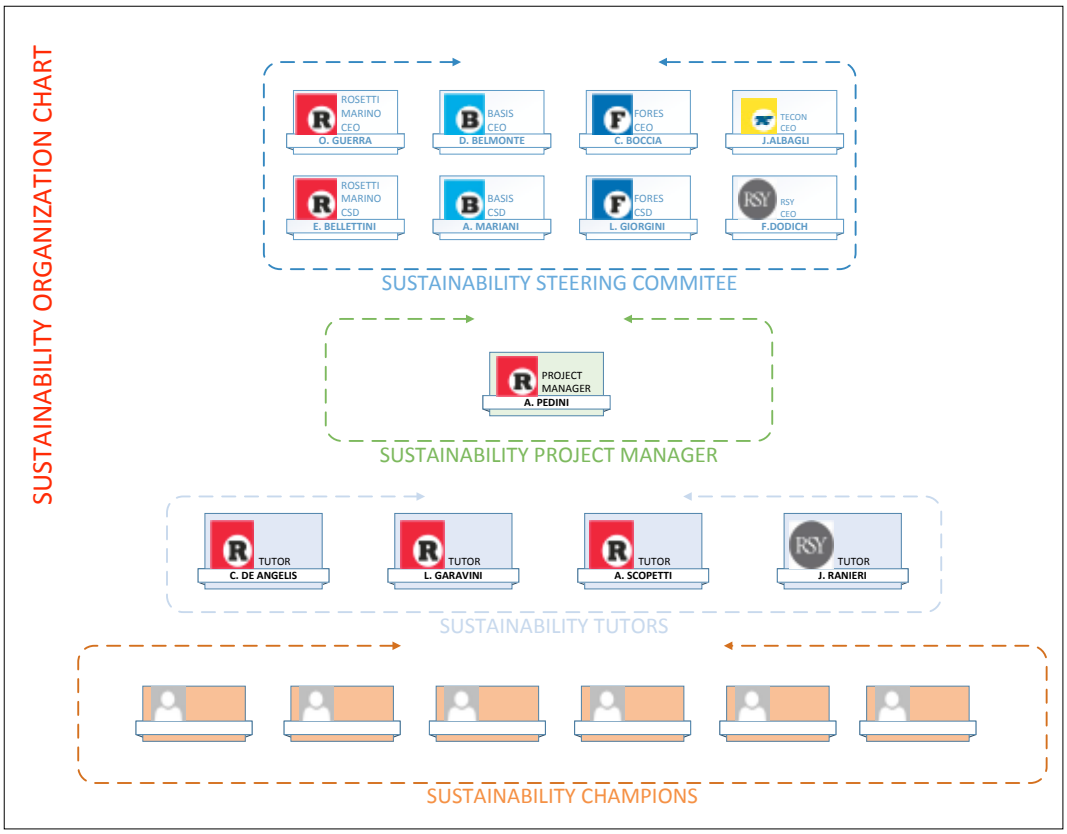
We did not involve any professional consultant; we've not instituted a company function that is dedicated to the development and deployment of our Sustainability model (e.g.: a Corporate Social Responsibility Officer), same, we did not adopt a management system based on existing international standards such as SA 8000 or ISO 26000.

With the sponsorship and commitment of the Top Management, we have decided to invest on our most important resource: the people.

"Our Sustainability Project started at the end of 2016 with a 'bottom-up' approach

Adopting a "bottom-up" approach, we involved forty among our youngest employees (under 30 years old), particularly interested in the sustainability issues, to whom we have made available a thematic training course, a set budget of time and money to develop proposals and to design a campaign to promote the Sustainability Culture within our Group of Companies.

Those Personnel ("Sustainability Champions") were

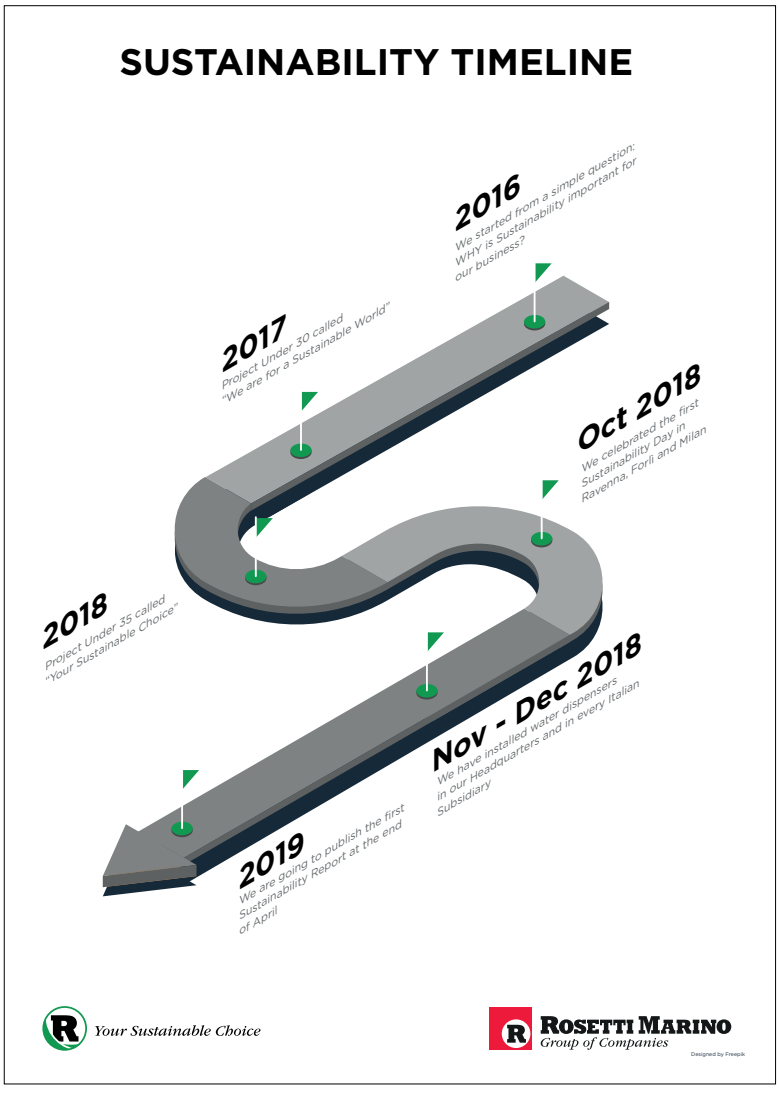



*Sustainability Organization Chart in Rosetti Marino Group of Companies (Italian subsidiaries)*

organized in team works, coordinated by a young Project Manager and supported by identified Tutors (employees with higher seniority and experienced);
the outputs emerged after 6 months from the work groups were evaluated by a Sustainability Steering Committee (composed of the managing directors and some managers of the Group). The "best outcomes" have been approved, budgeted and planned for execution in the two-year period 2018/2019.

Among the most significant activities (already implemented and nearing completion) regarding sustainability, we list:

- The issue of the first group Sustainability Policy which establishes the general objectives in terms of People, Environment, Ethics and Economic Development, Social Welfare;
- The launch of the communication campaign "Your Sustainable Choice", with the creation of a logo, statement, poster;
- The periodic issue of sustainability "pills" that promote attention and implementation of sustainable daily attitudes both in the workplace and in private life, to achieve global changes and results;
- The celebration of the first "Sustainability Day" (19 October 2018);
- Initiatives to monitor and achieve greater efficiency in the consumption of the main energy carriers (gas, electricity, fuel, etc.) characteristic of our production/service delivery;




*"Sustainability Timeline": developing our approach to sustainability from 2016 up to now*


*"Sustainability Meets Reality": deploying sustainable actions and goals*

- The rationalization in the use of resources and raw materials;
- Greater efficiency in waste sorting and collection with particular attention to reducing plastic consumption/waste;
- The installation of water dispensers and the distribution of an aluminum water bottle to all employees to reduce the consumption and rejection of plastic bottles;
- The identification of the Sustainability KPIs and definition of the Sustainability Goals, with the issue of the first sustainability report (the report is developed based on the GR4 guidelines of the Global Reporting Initiative);
- Sponsorship and participation in sporting and cultural events related to the territory;
- Solidarity initiatives in favor of the local community
- Collaboration with universities and educational institutions for development programs, internship and integration of young people into the world of work.

## Personnel Engagement

The bottom-up approach has enabled the activation of the "value chain", making our collaborators active with the aim of increasing the economic and moral values, the ethical reputation and internal impact value to our Group of Companies and in the reference territories.

The experience that involved heterogeneous work groups (in terms of roles and belonging to different companies) favored the integration, knowledge management, transversal development of the culture of sustainability and the dissemination of values.

"The experience from the involvement of heterogeneous work groups favored the integration, knowledge management, company-wide development of the culture of sustainability and the dissemination of its values

The project has also allowed the definition of an induction plan on sustainability that allows the continuity and involvement of employees and new hires to be transmitted.

## Next Steps

We have identified in the following steps the opportunities to be seized as Rosetti Marino Group of Companies on sustainability:

- The implementation of the sustainable KPI's to measure our performance, understand its trends,


identify opportunities for continuous improvement.

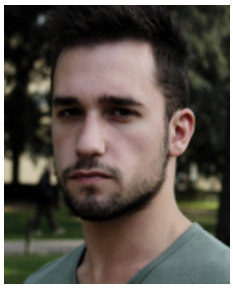
- Increasing involvement of stakeholders and in particular the Supply Chain and Customers on our sustainability initiatives.
- The consolidation of the internationalization process to be developed according to the “Many Countries, Many People, The Same Values” principle, and in particular:

a. Export the sustainability model to the foreign companies of the group, controlled or participated, taking into account the characteristics and peculiarities of each workplace and community in which we operate
b. Guarantee the technological transfer necessary to maintain the business and enhance the local content
c. Support wherever possible initiatives in favor of the development of local communities

Important challenges await us that require effort, commitment and attention that allow us to innovate and increase the economic, social and environmental sustainability deriving from our products and services.

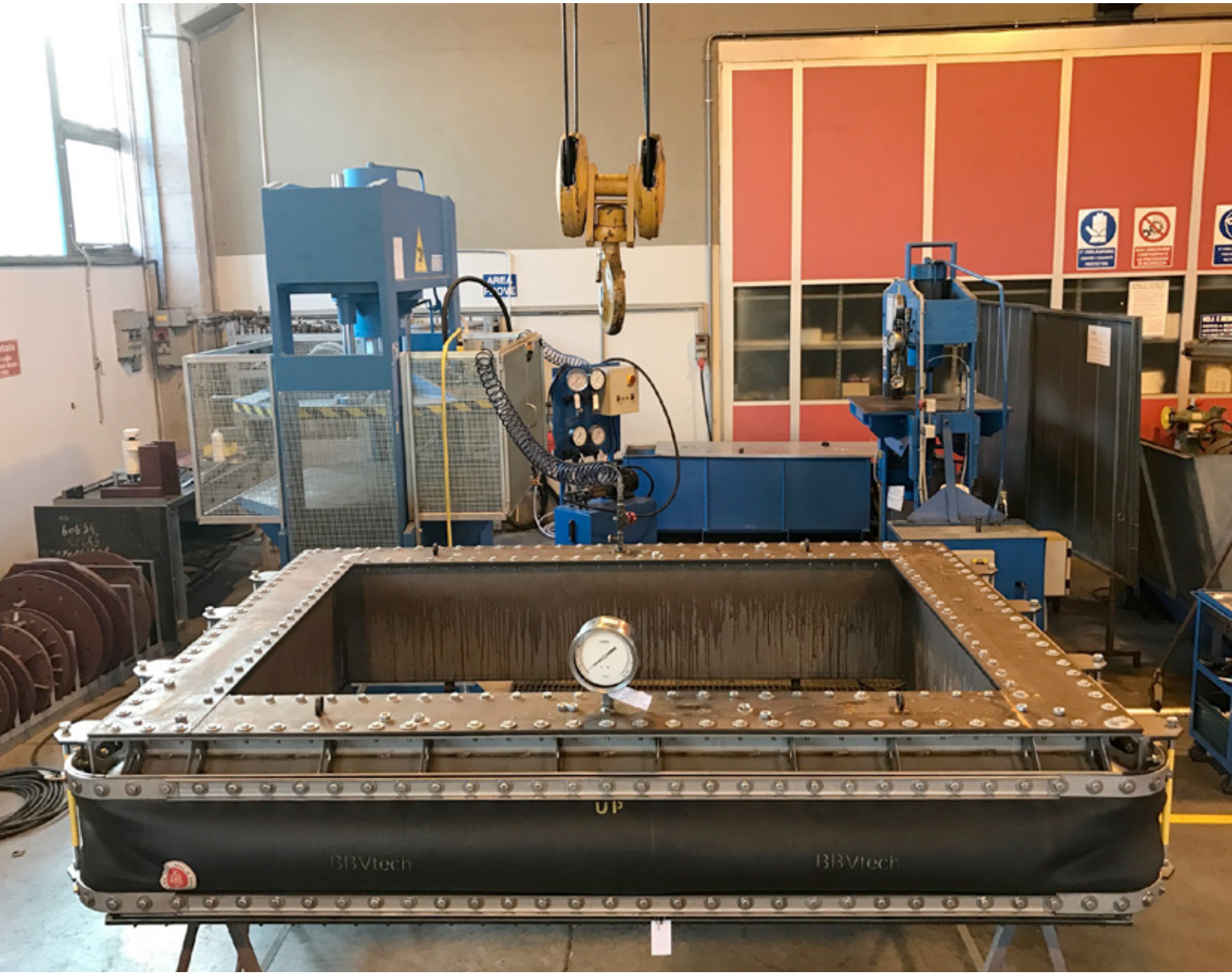
## Aldo Scopetti

Aldo Scopetti started his career in Rosetti Marino in 2006. Before becoming HSSEQ Manager, he worked in the Project Quality Management and in the organization and development of foreign subsidiaries. Since December 2016, he is leading and tutoring a team of young colleagues with the aim to develop and implement the first Rosetti Marino corporate sustainability program.



## Alessandro Pedini

Alessandro Pedini has been working in the Communications Department of Rosetti Marino since 2015. Since beginning of 2017 he has been nominated Project Manager for the company initiatives dedicated to Sustainable Development and for the creation and diffusion of the Sustainability Culture within Rosetti Marino organization.




# A New Generation of High-Performance and Eco-Friendly Textile Expansion Joints

Excellent results from a well-designed innovation program

**Stefano Boni,** Director of the R&D Production Department
**Luigi Valfrè,** Consultant
Gruppo BBV

In 2006, *BBV Tech S.r.l.* (*Alflex*), a manufacturing company that is part of the *BBV Inoflex Group*, was called upon to manage and develop the *Production Department for Layered Textile and Rubber Products* and launched a specific research and development project to create a new generation of high-performance textile expansion joints. At the same time, studies have been carried out on several levels: analysis and design criteria, materials, and production processes.

The Innovation Program followed the development of naval shipbuilding projects by the Italian Navy that include the *FREMM frigates*, the new *PPPs - Multipurpose deep-sea patrol boats* and the *LHD - Landing Helicopter Dock*, under construction. The objective of the study was a set of textile expansion joints to be used in the output lines from gas turbine modules (by *General Electric* and *Rolls Royce*), to be placed in internal seals like engine shaft protection, and to connect the piping of gas exhaust, primary air and ventilation.

**In 2006, BBV Tech S.r.l. (Alflex), launched a specific research and development project to create a new generation of high-performance textile expansion joints**

In launching the Project, a strategic decision was made to question every technological and knowledge element already acquired through known technologies. At the same time, also favored by a similar intent of the clients, each new course of study was undertaken with the imperative of not setting limits on *dual-use technology* research, especially in order to seek new technological solutions useful to reconcile:

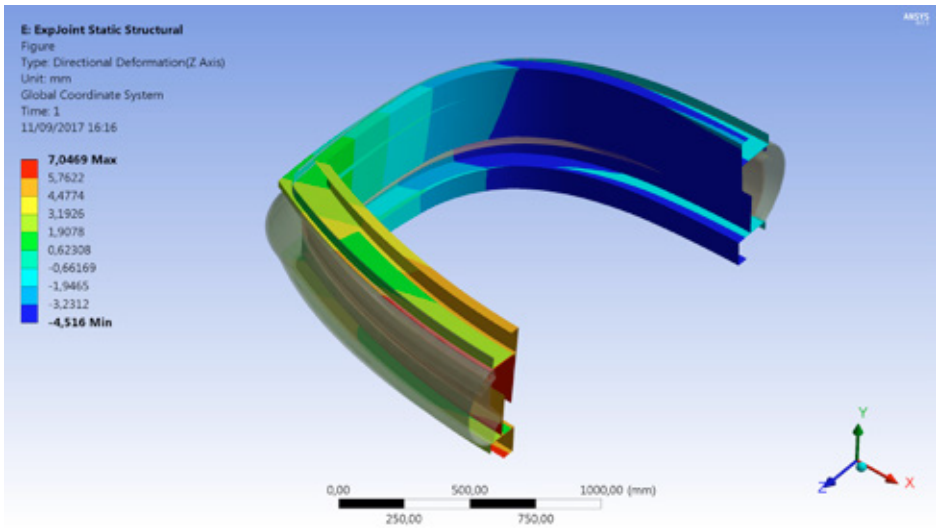
- the need to create systems capable of delivering ever-higher performance and
- the determination to contribute to a decisive reduction of pollutants (both acoustic and from the release of harmful chemical compounds into the environment).

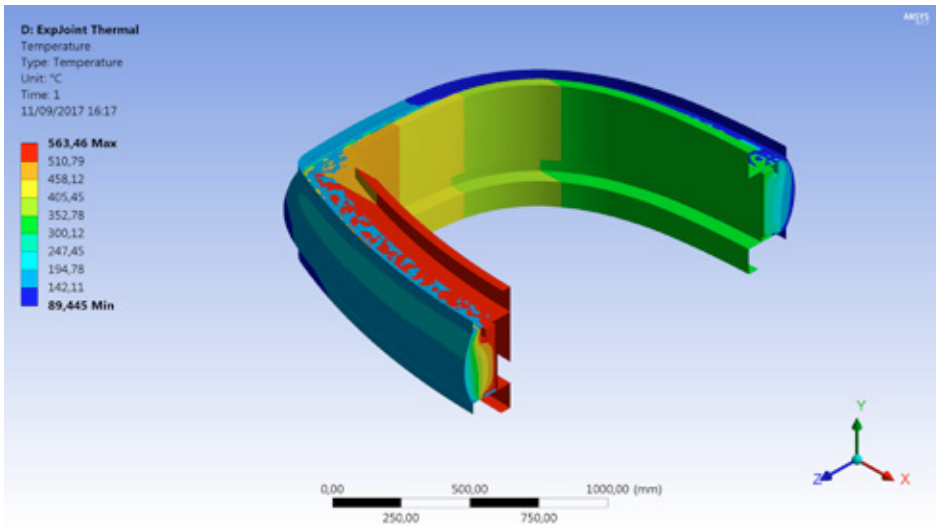
It was crucial to start with a thorough analysis of data concerning the design, construction and operational life of expansion joints coming off production lines and, over a forty year period, installed in thousands of industrial plants located all over the world. These were, in numerous cases, subjected to extremely complex working conditions due to both the environmental situation (sometimes extreme) and on the operating characteristics of the plants.

**The innovation acquired has made it possible to achieve 100% of the desired performances, guaranteeing ship operational and stealth capabilities unthinkable with "mature" technologies**

During the development of the project, *performance targets* were continuously raised according to ever-increasing levels of required operational capacity by the new ships.

The absolute rate of innovation acquired has made it



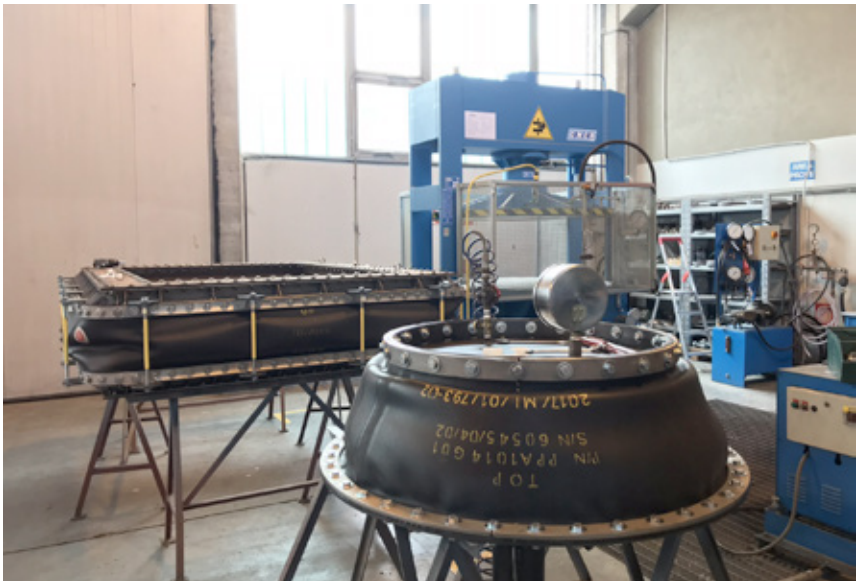
## The following tables show some data on the operation of the expansion joints under normal conditions.

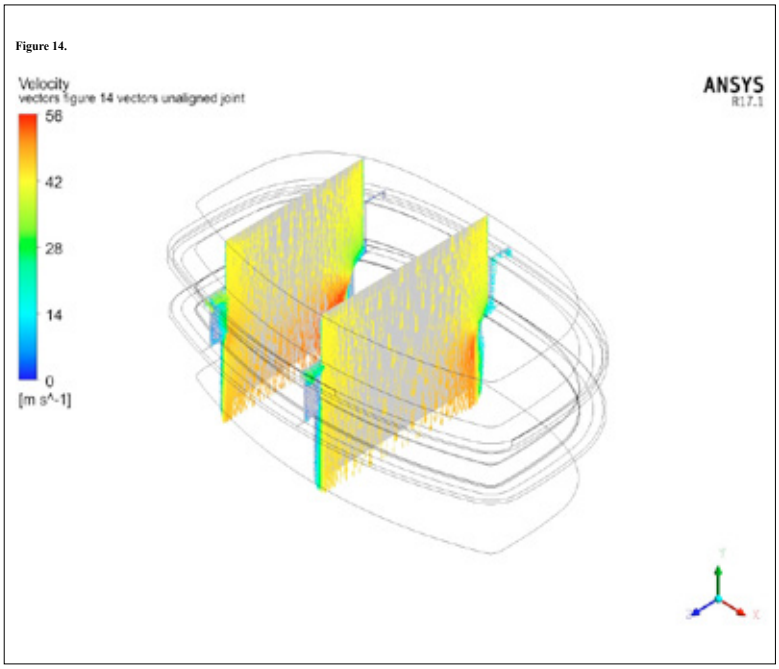
| **PROJECT:** | **FREMM - European Multi Mission Frigate**<br>**PPPs - Multipurpose deep-sea patrol boats** |
|---|---|
| Type of turbine: | LM2500+G4 Propulsion system |
| Power: | 32 MW |
| Expansion joints provide an airtight, noise and temperature-attenuating seal between the enclosure and the ship's ducts and between the enclosure and the reduction gear box. | |
| **PRIMARY INLET:** | Rectangular expansion joint that forms the airflow path between the ship's intake duct and the enclosure primary air inlet penetration. |
| Performances requirements: | |
| Fluid: | AIR |
| Pressure: | -2.5 kPag normal condition<br>20.7 kPag short term condition |
| Temperature: | Min. -20 °C<br>Max +49 °C |
| Axial Movements: | Normal ±13 mm / Short Term ±25 mm / Shock ±51mm |
| Lateral Movements (1): | Normal ±5 mm / Short Term ±13 mm / Shock ±25mm |
| Lateral Movements (2): | Normal ±8 mm / Short Term ±25 mm / Shock ±45mm |
| **SECONDARY INLET:** | Circular expansion joint that forms the airflow path between the secondary cooling enclosure for air inlet penetration and the ship's cooling air duct. |
| Performances requirements: | |
| Fluid: | AIR |
| Pressure: | 3.5 kPag normal condition<br>20.7 kPag short term condition |
| Temperature: | Min. -20 °C<br>Max +121 °C |
| Axial Movements: | Normal ±13 mm / Short Term ±25 mm / Shock ±51mm |
| Lateral Movements (1): | Normal ±5 mm / Short Term ±13 mm / Shock ±25mm |
| Lateral Movements (2): | Normal ±8 mm / Short Term ±25 mm / Shock ±45mm |
| **PRIMARY EXHAUST GAS:** | Rectangular expansion joint that forms the air path for the discharge of the secondary cooling air from the enclosure into the ship's exhaust uptake duct. |
| Performances requirements: | |
| Fluid: | EXHAUST GAS |
| Pressure: | 3.5 kPag normal condition<br>20.7 kPag short term condition |
| Temperature: | Min. 0 °C<br>Max +427 °C |
| Axial Movements: | Normal ±13 mm / Short Term ±25 mm / Shock ±64mm |
| Lateral Movements (1): | Normal ±5 mm / Short Term ±13 mm / Shock ±35mm |
| Lateral Movements (2): | Normal ±8 mm / Short Term ±25 mm / Shock ±51mm |
| **SHAFT SHROUD:** | Circular expansion joint that encloses the power coupling shaft between the gas turbine module and reduction gearbox. |
| Performances requirements: | |
| Fluid: | AIR |
| Pressure: | -1.7/3.5 kPag normal condition<br>20.7 kPag short term condition |
| Temperature: | Min. -20 °C<br>Max +121 °C |
| Axial Movements: | Normal ±5 mm / Short Term ±13 mm / Shock ±25mm |
| Lateral Movements (1): | Normal ±5 mm / Short Term ±19 mm / Shock ±25mm |
| Lateral Movements (2): | Normal ±20 mm / Short Term ±25 mm / Shock ±50mm |
| **DESIGN AND TEST PERFORMED:** | |
| - TEST FOR SURFACE FLAMMABILITY – IMO Res. A. 653 (16) FTP Code MSC 61 (67)<br>- PRESSURE TEST – AVIO SPC07-00195<br>- LEAKAGE TEST – AVIO SPC07-00195<br>- VIBRATION TEST – IEC 60068-2-47 – ISO2041<br>- ACOUSTIC TEST - AVIO SPC07-00195 – ISO 1683:1983 | |

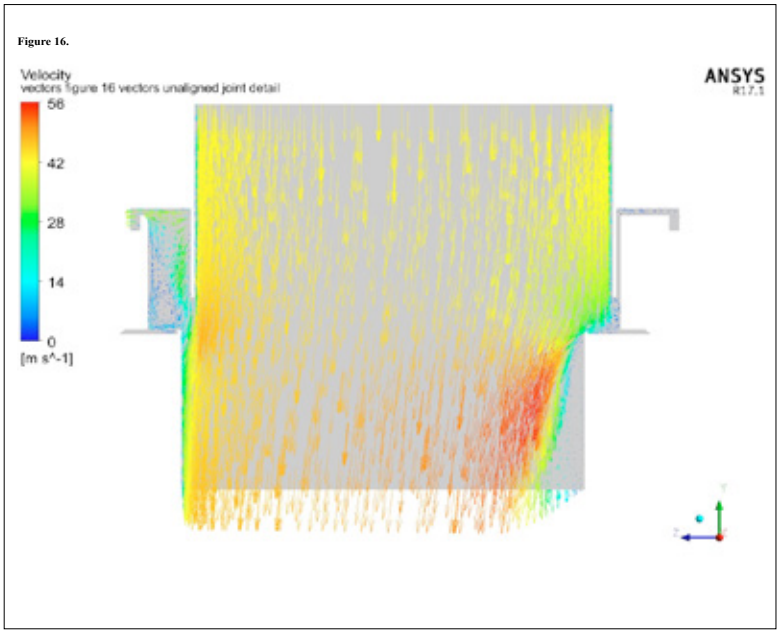
| PROJECT: | - LHD Landing Helicopter Dock |
|---|---|
| Type of turbine: | MT30 Rolls-Royce |
| Power: | 40 MW |
| Expansion joints provide airtight, noise and temperature attenuating seal between the compact package and the ship's ducts. | |
| **INTAKE:** | Rectangular expansion joint that is the MT30 Compact Package intake Bellow interface with the ship air intake ducting. |
| Performances requirements: | |
| Fluid: | AIR |
| Pressure: | 5 kPa max |
| Flow: | 116 Kg/s (19.3 m/s) |
| Temperature: | Min. -20 °C<br>Max +49 °C |
| Axial Movements: | -68 mm / +56 mm |
| Lateral Movements (1&2): | ±56 mm |
| **VENTILATION:** | Rectangular expansion joint that is the MT30 Compact Package Ventilation Bellow interface with the ship ventilation ducting. |
| Performances requirements: | |
| Fluid: | AIR |
| Pressure: | -1 kPa max |
| Flow: | 20 Kg/s (10 m/s) |
| Temperature: | Min. -20 °C<br>Max +49 °C |
| Axial Movements: | -75 mm / +62 mm |
| Lateral Movements (1&2): | ±55 mm |
| **PRIMARY EXHAUST:** | Special shape expansion joint that is the MT30 Compact Package Exhaust Bellow interface with the ship exhaust ducting. |
| Performances requirements: | |
| Fluid: | EXHAUST GAS |
| Pressure: | 5 kPa max |
| Flow: | 119.2 Kg/s (40 m/s) |
| Temperature: | up to 581 °C |
| Axial Movements: | -75 mm / +60 mm |
| Lateral Movements (1&2): | ±50 mm |

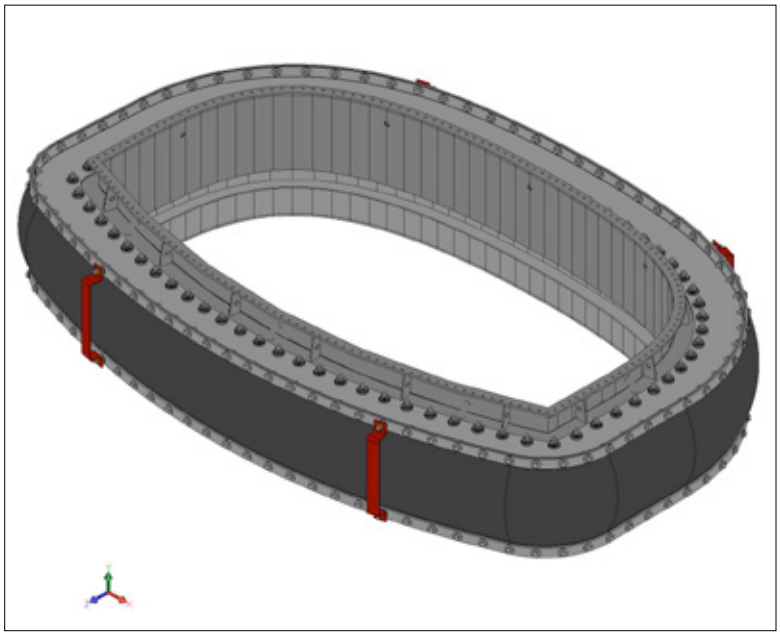
**DESIGN AND TEST PERFORMED:**

- THERMAL AND MECHANICAL ANALISYS.
- FLUID-DYNAMIC ANALISYS.
- EXPANSION JOINT MODAL SIMULATION.
- SMOKE AND TOXICITY TEST – FTP CODE 307 (88) Ed. 2010 Annex 1 Part 2
- TEST FOR SURFACE FLAMMABILITY – FTP CODE 307 (88) Ed. 2010 Annex 1 Part 5
- PRESSURE TEST – INTERNAL PROCEDURE PR-60742/17-03
- LEAKAGE TEST – INTERNAL PROCEDURE PR-60742/17-03
- DISPLACEMENTS TEST – INTERNAL STD.
- STIFFNESS TEST – INTERNAL STD.





possible to achieve 100% of the desired performances in the project, guaranteeing ship operational and *stealth* capabilities unthinkable with "mature" technologies.

With 20 ships fully in service, the first for over 10 years, and without any operating incident having occurred, it has been confirmed that the new generation of textile expansion joints have a 100% degree of reliability compared to the originally-requested warranty terms.

The project is undergoing further development and promises to provide further important application innovations.

As it often happens, military research opens up wide spaces of "portability" in merchant shipbuilding as well as in the civil and commercial industries.
In fact, the technological innovations acquired fully (and naturally) respond to current global policies that strongly push us toward developing the use of Liquefied Natural Gas (LNG) in order to significantly reduce pollution caused by combustion of raw fuels that are much less refined and more polluting.
Indeed, LNG is the most environmentally friendly fossil fuel in the world. For the shipbuilding industry, the use of LNG represents the adoption of the most innovative propulsion technology.

**The new generation of textile expansion joints have a 100% degree of reliability compared to the originally-requested warranty terms**

Technological change, strongly oriented towards the protection of the environment, among other things, will make it possible to travel by ship without being accompanied by the unpleasant smell of exhaust gases.
In addition, textile expansion joints, as an alternative to metal ones, guarantee a better level of silence and, depending on the application, can lighten lines where they are installed. This last factor is of great importance, given that the size of new ships is constantly increasing.

## Stefano Boni

Stefano Boni, Director of the R&D Production Department of Gruppo BBV.
He joined Alflex S.r.l. in the early 1980's and was an active part of the team that brought the technology of planning and production of fabric expansion joints from the U.S.A. to Italy. Later, he became Head of the Technical Office at Alflex – Expansion Joints S.r.l. and worked on all the "in house" research and development projects as well as those jointly conducted with American industrial partners. With the acquisition of Alflex-CDD by BBV Tech S.r.l. and the birth of Gruppo BBV, he acquired his present function.

## Luigi Valfrè

Luigi Valfrè collaborates with Gruppo BBV in the revision and industrialization of internal processes inherent in technical functions, production lines and research and development.
He graduated in engineering at the University of Genova.
He has over 25 years of experience in the design and installation of industrial and power plants with ABB, where he had a variety of responsibilities, among which were Director of the Business Unit and Country Manager in Algeria. He is the coauthor of various technical articles published in CIGRE and CIRED.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# Upgrading the electrical system infrastructure of a refinery in North Europe

Project management strategies and engineering solutions for one of the largest electrical upgrading projects ever executed in Northern Europe

**Cesare Boeri,** Senior Project Manager - Wood
**Massimo Vanossi,** Electrical Engineering Manager - Wood

The electrical infrastructure in many of the refineries in Europe are as old as the refineries themselves. These systems have been subject to years of continuous modifications and extensions; in parallel with the revamping of the units, the addition of new process units and new electrical users.

In most cases, these modifications include installing equipment such as transformers, switchgears and battery chargers, from different manufacturers, and often with limited consideration for the effects on the overall system architecture.

Such situations can impact the compliance of the electrical codes and standard for the system, as well as reduce the reliability and safety. Hidden costs for maintenance and spare parts for system can increase due to difficulties in obtaining parts for aged equipment, and in some cases, a presence of asbestos can be found in electrical switchgears and other electrical equipment. A refinery in North Europe required an extensive upgrading of the electrical infrastructure due to these circumstances and needed to improve the safety level for electrical operators and maintenance personnel, as well as the reliability and maintainability of the overall infrastructure.

This paper includes highlights of the project management strategies and engineering solutions for such electrical upgrading project, that is one of the largest ever executed in North Europe.

## Project objectives

The implementation of a plant-wide electrical system upgrading project, which involves replacing the majority of the substation electrical equipment, has several project objectives:

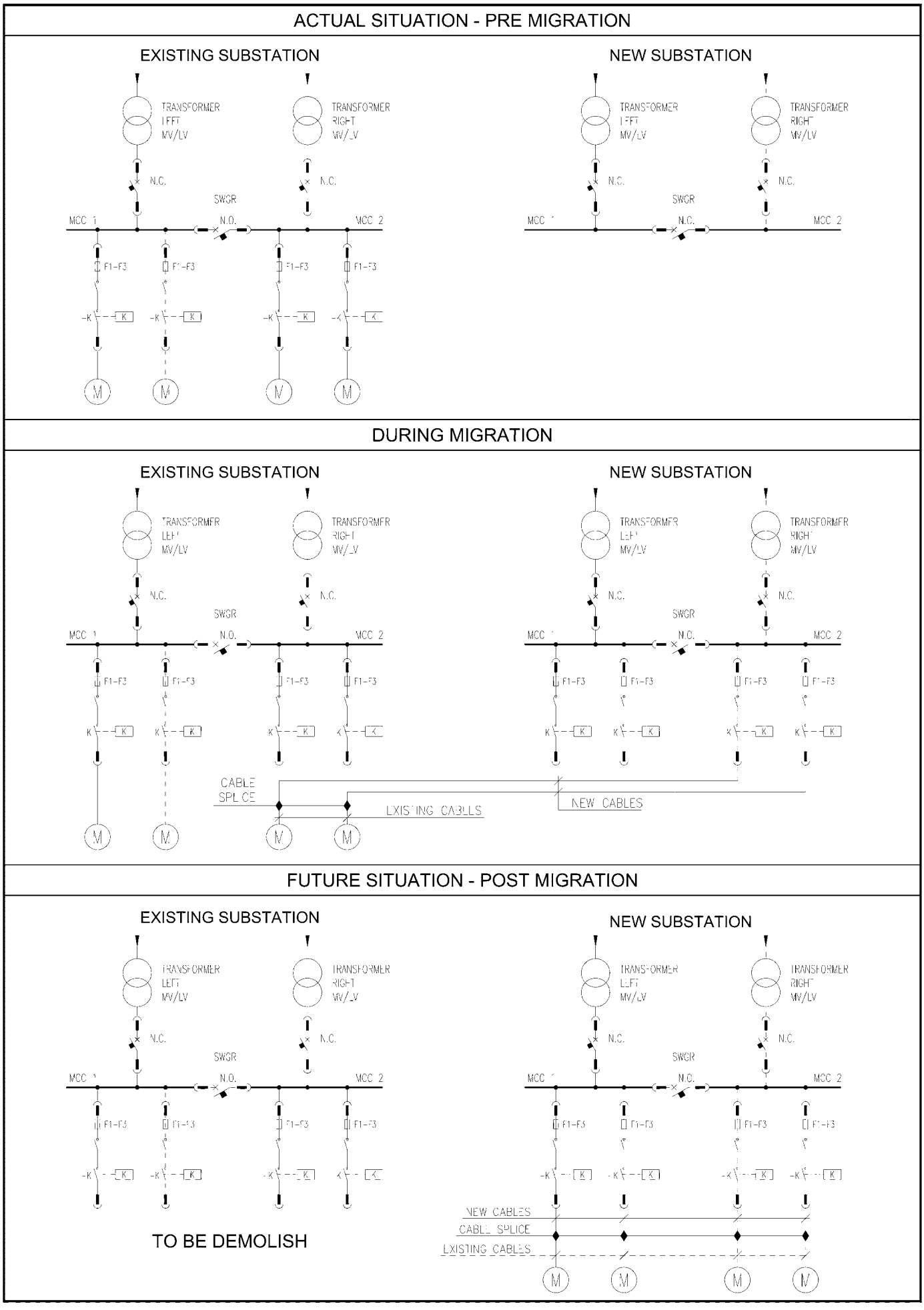
- increase the safety for both operators and maintenance personnel by replacing existing aged equipment with new state-of-the-art equipment
- achieve compliance with electrical standards and codes, compliance with electrical codes related to arc flash (IEC 62271-200 for MV switchgear and IEC/TR 61641 for LV switchgear)
- improve the electrical network reliability, operability and functionality
- mitigate the electrocution and arc flash risks associated to rack in/out and current measurement activities performed on low voltage MCCs
- standardise the electrical system design and components throughout the refinery to simplify training and maintenance operation, and to reduce the capital spare
- implement full communication between MV and LV switchgears, other electrical equipment installed in the electrical substations and the central control room.

## Project highlights

**Project scope**

At the beginning of the project, the existing refinery electrical system was constituted by a secondary

*Fig. 1*


ACTUAL SITUATION - PRE MIGRATION
EXISTING SUBSTATION
NEW SUBSTATION
TRANSFORMER LEFT MV/LV
TRANSFORMER RIGHT MV/LV
N.C.
SWGR
N.O.
MCC 1
MCC 2
F1-F3
K
M
DURING MIGRATION
EXISTING SUBSTATION
NEW SUBSTATION
CABLE SPLICE
EXISTING CABLES
NEW CABLES
FUTURE SITUATION - POST MIGRATION
EXISTING SUBSTATION
NEW SUBSTATION
TO BE DEMOLISH
NEW CABLES
CABLE SPLICE
EXISTING CABLES

selective scheme with some substations supplied in parallel from upstream step-down transformers.
The overall upgrading project required:

- 20 existing electrical substations
- 45 existing MV loads
- more than 1000 existing LV loads

The upgrading project modifies the refinery electrical system configuration by means of:

- installation of one single new "state-of-the-art" 3.3kV switchgear, suitable to feed all the 3.3.kV loads of MV substations
- installation in each master substation required the following new equipment:
  - MV/LV power transformers
  - LV MCC switchgears complete with intelligent relays
  - new bus duct system to connect the above items
  - new DC Power supply system to feed 110 Vdc to all control circuits
  - new MCC PLC controller suitable to allow both the monitoring and control of each circuit breaker from the central control room and to gather other operational data from all substation equipment
  - new very early smoke detection system (Vesda) in all new and revamped substations
  - new alarm panel connected to the central control room to monitor substation alarms.

**Transition / migration from the old to the new system configuration**

Due to the overall project dimensions, and to avoid any disruption to refinery operation, the transition from the old to the new electrical system configuration have been phased as follows:

- per individual substation
- per individual load

The required tie ins, mainly constituted by empty MV and LV switchgear columns in existing substations, have been prepared during the planned refinery turnaround.
The high-level one-line diagrams below show the system configuration before, during and after the load migration completion of each involved substation (**Fig. 1**).

**Project phasing**

Due to the significant extension of the existing electrical infrastructure, the project execution has been split into various phases: the first phase, which started in 2014, and a second phase which will end after the next refinery turnaround in mid-2021.
The high-level master plan of the project has been defined by the owner, taking into consideration the refinery operational requirements, whilst the detailed planning of each work phase has been defined by Wood.
Each project phase includes the following activities:

- definition of preliminary design basis by the refinery owner
- FEED package development by Wood
- EP (detailed engineering and procurement) by Wood
- construction ready for commissioning status for the upgraded electrical system, managed by an integrated team including both Wood and owner specialists
- commissioning start-up and load migration (with the refinery units in operation) carried out by owner's start-up team with the assistance of the integrated construction team
- dismantling of the obsolete equipment and restoring of the electrical substations managed by an integrated team including both Wood and owner specialists

The adopted staggered execution approach, and relevant planning, has been designed to assure a constant workload during the project execution to all parties involved, including the transformer and switchgear manufacturers as shown in **Fig. 2**:

## Project execution

***Selection of Wood as the EPC contractor***

For the execution of the project, the owner has selected Wood as EPC contractor considering:

- the previous successful execution of a plant wide instrument and automation upgrading project for the same refinery
- the previous successful completion of a new cogeneration unit
- the deep knowledge of owner engineering and execution standards
- the experience in country and the relevant knowledge of local suppliers and construction contractors.

***Project execution priorities***

The execution strategy has been defined to achieve the project objectives with the following priorities:

- safety
- quality
- cost & schedule

as well as the following requirements / criteria:

- minimise / avoid any disruption to refinery operation
- prioritise the upgrading of the oldest and unsafe substations
- spread investment costs over several years
- assure a smooth and constant work load over the project duration for all involved parties including:
  - engineering and procurement team

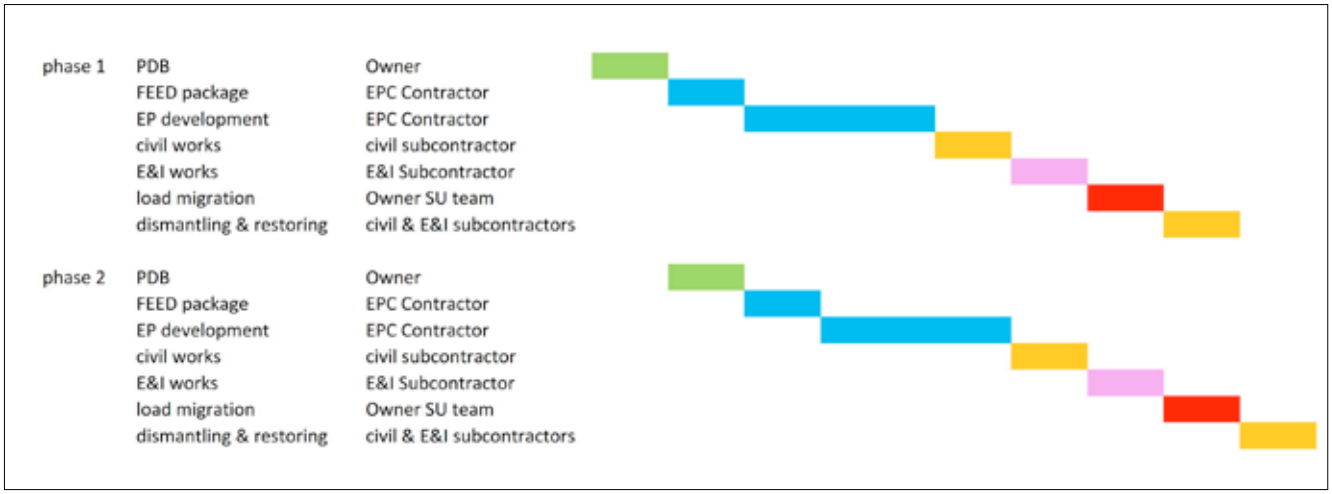



*Fig. 2*

- site construction team
- site start-up team
- switchgears and transformer manufacturer.

***Project phasing***

Due to the above points, the overall scope of the electrical upgrading project has been split into eight phases. These are seen in the table below:

Each project phase has been split further into various sub phases as mentioned above (**Tab. 1**).

***Technical solutions***

In order to avoid / minimise any disruption to refinery operations, it is necessary to install, connect and energize the new electrical equipment with the existing ones in operation.

To achieve this, specific technical solutions have been implemented, as shown in the following figures **3, 4 and 5**:

- installation of the new electrical switchgear cabinets in the available space within existing substations, proceeding with a phased cabinet installation and dismantling
- extension of the existing substation building to obtain additional space suitable for the installation of the new electrical equipment
- installation of the new electrical equipment in the new fully pre-fabricated electrical substation shelters.

**Project execution criteria**

After having defined the project execution concepts, the following key execution criteria have been applied to each phase of the project:

- complete the documentation and data collection during each FEED phase to allow a smooth development of detailed engineering
- early execution, during FEED phase, of trial excavation and sleeve positioning for new piles for both new substations and new transformers bays, to allow a smooth construction execution
- maximisation of pre-fabrication works for both civil and electrical systems
- early engagement with the main suppliers during the EP phase to anticipate the detailed engineering activities and obtain the drawings required for the development of civil design activities
- preparation and presentation before the start of each piece of erection work, including construction work packages (CWP's) for the integrated construction management team and construction contractor to share the engineering solutions, anticipate any constructability issues and allow a smooth construction execution
- early involvement of the electrical notified body to share the engineering solutions for the FEED phase to manage time and cost risks
- detailed construction planning and sequencing defined during engineering phase and further refinement in field

*Tab. 1*

| Project phase | Status in March 2019 | Purpose | Substations | Loads |
|---|---|---|---|---|
| 0 | Completed | Tie ins preparation during refinery TA | No. 6 sub | 12 empty MV cells installed |
| 1 | Completed | MV substation upgrading and consolidation | No. 1 sub | 45 |
| 2A | Completed | LV substation upgrading | No. 4 sub | 285 |
| 2B1 | Completed | LV substation upgrading | No. 1 sub | 146 |
| 2B2 | Completed | LV substation upgrading | No. 1 sub | 112 |
| 2C1 | completed | LV substation upgrading | No. 1 sub | 122 |
| 2C2 | completed | LV substation upgrading | No. 1 sub | 147 |
| 2D | FEED completed, EPCa in progress | LV substation upgrading | No. 4 sub | 233 |

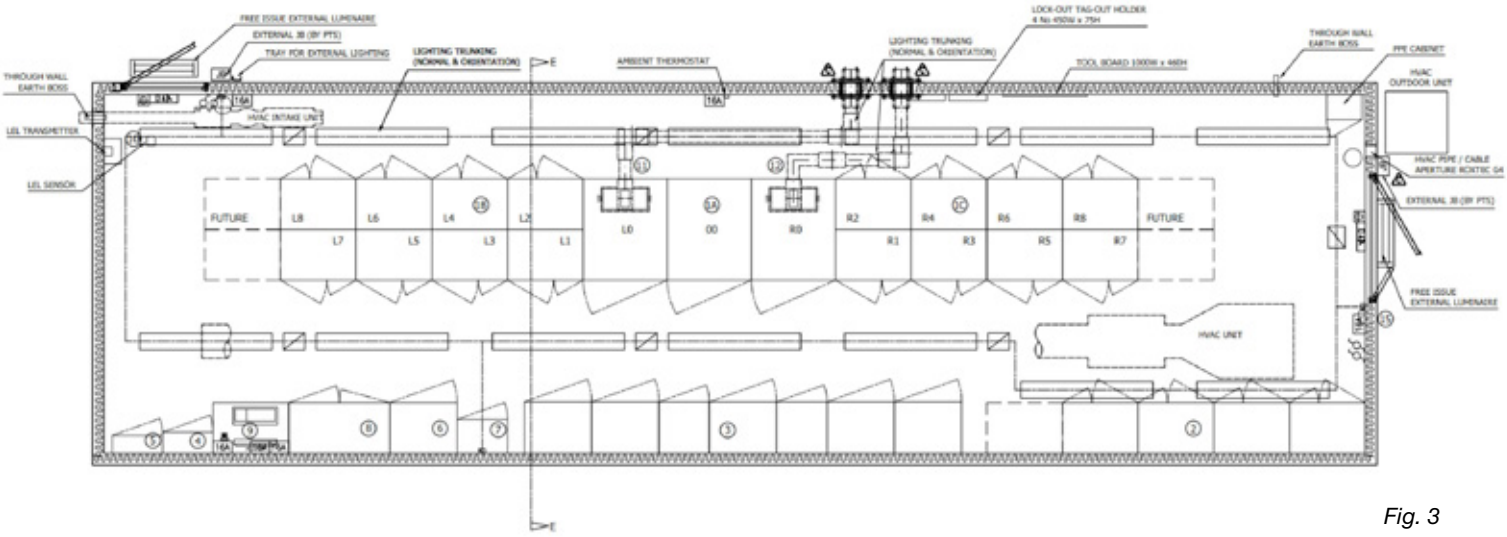



*Fig. 3*

*Fig. 4*

*Fig. 5*

- close coordination among engineering, construction, start-up teams and refinery operations
- implementation of a continuous project execution improvement plan.

**Continuous project execution improvement**

The set-up of a continuous project execution improvement plan has been essential to improve the safety performance, quality, cost and schedule for all parties involved during the multiple project phases.

***Safety***

The execution of the construction work, from the start of civil works up to the load migration by means of cable splicing, poses a wide range of safety hazards considering that all work being executed is on a running plant, in the presence of a live electrical system and avoiding any disruption to the operations.

To reduce the impact of hazards, specific construction and testing procedures have been defined after accurate risk analysis in compliance with refinery safety procedures.

To continue the safe performance of the construction team, in addition to the traditional safety statistics, all construction supervisors have been subject to several session on project specific safety training, exams and certifications according to their respective duties and responsibilities.

To ensure the safety of personnel, special precautions have been implemented to protect existing electrical equipment in operation during construction and test execution.

The execution of similar activities for different electrical substations gave the opportunity to continuously improve the construction sequences and method statement with positive effect on project safety KPI's.

***Lessons learnt***

Quarterly, during the project execution, lessons learnt sessions have been held among the various team including:

- owner – Wood integrated project team
- integrated construction team at site
- start-up team
- main suppliers and subcontractors.

In these sessions, all project aspects have been analyzed and evaluated in detail including:

- engineering
- procurement
- inspection
- subcontracting
- construction and testing
- scheduling
- commissioning.

Lessons learnt has advantages for the project execution such as:

- optimisation and standardisation of engineering

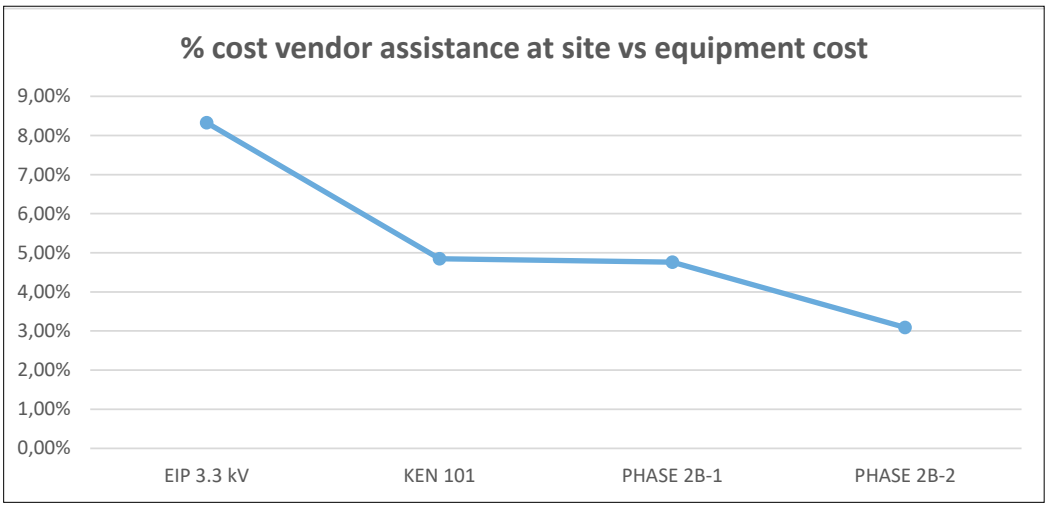



*Fig. 6*

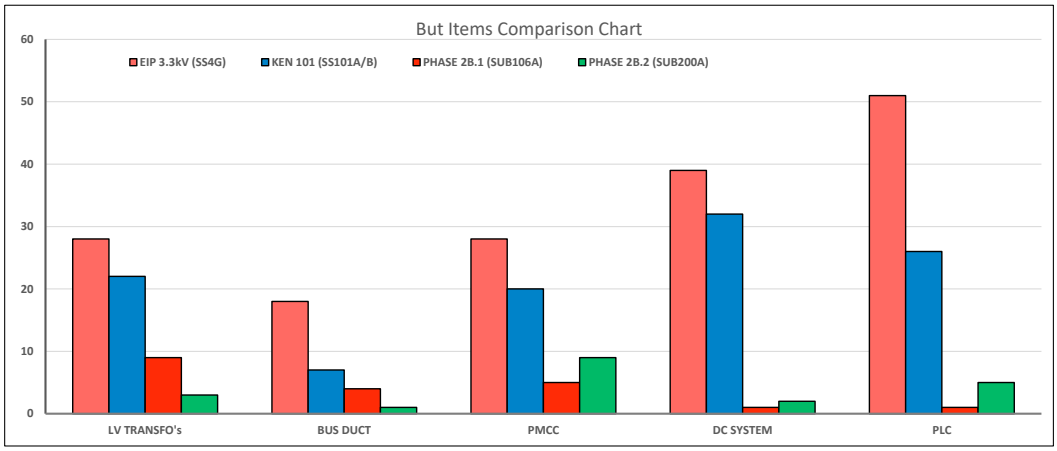



*Fig. 7*

solutions as required to simplify the construction execution at the site, reducing the relevant risks
- improvement of both procurement and subcontracting activities
- improvement of inspection and testing activities at vendor shops
- maximisation of pre-fabrication
- improvement of the construction details on drawings to simplify and improve the construction works in the field
- improvement of the construction procedures and method statements
- reduction of the risks associated with construction, testing and load migration activities.

***Key Performance Indicators (KPIs)***

Various project specific KPIs have been identified to measure and monitor the performance on the various project phases:

*ratio between the cost of vendor assistance and the equipment cost:*

the strict monitoring, during project execution, of the vendor assistance requirements has allowed a significant reduction in the relevant costs; this result has been achieved by increasing the extent of checks and controls during factory acceptance test, and redefining the split of responsibilities among the involved parties during the pre-comm and commissioning phases.

*but items number per system:*

this parameter has been useful to measure and improve the quality of both FAT and construction activities, and the punch list process; the reduction of but list items per equipment has had a beneficial impact on schedule, and consequently on costs (**Fig. 6 and 7**).

***Project team performance***

The set up and keeping of a cohesive and motivated integrated team both in H.O, and at site has been essential to allow the achievement of the project targets and implementation of the continuous improvement plan.

The following initiatives have been pursued to keep the team motivated:
- celebration on targets achievement
- seamless communications between home office team, construction and start-up team
- selection of team members with strong safety behavior and a passion for high quality jobs common targets for all parties involved.

It is to be noted that the timely implementation of construction lessons learnt on engineering drawings also significantly contributed to increase the confidence of construction and start-up team, versus the engineering team.

## Engineering solutions

The execution of the electrical upgrading project has provided an opportunity to study and implement various innovative engineering solutions refined and perfected during the project execution; those listed below could be replicated on traditional revamping or grass root projects.

**Prefabricated transformer bays**

A first example of design evolution is well represented by the design of the transformer bays that has been gradually changed from fully stick-built to fully pre-fabricated solution as shown below:

- pre-fabricated trafo basin on stick-built pillars and prefabricated steel fire wall (see **fig. 8**)
- pre-fabricated trafo basin and concrete fire walls
- pre-fabricated trafo basin and concrete fire walls installed on prefabricated steel structure

The implementation of the extended pre-fabrication approach on transformers bays allowed the achievement of following significant results:

- risks and hazard reduction during construction works execution
- high quality assembly and construction
- saving on construction costs and time.

**Pre-fabricated substation shelter and supporting structure**

In few cases, where no other feasible solutions were available, the project scope included the installation of the new electrical equipment in new pre-fabricated substation shelters.

The most significant examples are represented by three pre-fabricated substations shelters feeding up to 150 LV loads each including:

- pre-fabricated and assembled supporting structures and platforms
- pre-fabricated fire-resistant substation shelter complete with:
  - HVAC system
  - interconnected electrical equipment (LV Switchgear, TAPC, DC power supply system, PLC Controller, VESDA, alarm panel, bus duct.

After the installation within the substation, under the supervision of Wood electrical engineers at the manufacturer workshop, all electrical equipment has been inspected by the notified body and fully tested by an integrated team (**Fig. 9**).

*Fig. 8*

*Fig. 9*

Upon completion of the testing activities, the substation shelters have been transported by ferry and low bed trailer from the manufacturer work shop up to the installation location within the refinery.

The implementation of the extended pre-fabrication approach on substation shelter allowed the achievement of significant results such as: risks and hazard reduction during construction works execution; high quality assembly and construction; saving on construction and testing costs and time.

**Migration sequence**

The load migration preparation and execution required, for each substation and electrical system, significant effort by all involved parties for the following items:

- preparation of a clear field procedure defining the split of responsibilities and the safety procedure to be adopted during the whole load transfer migration process
- definition of construction sequences in conjunction with start-up team according to the planned system commissioning sequence
- coordination between start up team and process operation to agree on detailed planning for loads migration (user by user)
- individual TOS (Turn Over System) package

preparation for each load to be migrated including detailed connection diagrams, test certificates, installation quality forms

- materials preparation including cable splices of different sizes according to cable compositions and resins suitable for the ambient temperature
- substation cable cellar preparation in order to improve the working environment and render as smooth as possible the job execution.

The loads migration has been implemented by splicing, in the cable cellar, the existing users' power and control cables to the new cables previously connected to the new switchgears (**Fig. 10**).

*Fig. 10*

Existing cables have been cut by the start-up team and splices have been executed by appointed E&I contractor under Wood/owner supervision.

## Conclusions

The execution of a plant-wide electrical upgrading project is complex and consists of several challenges, as described in this paper, including safety during engineering, construction, testing and load migration; works in presence of live equipment; risks to plant operation; innovative design solutions.

Such challenges can only be successfully faced by EPC contractors with experiences on this type of execution of complex, plant-wide, instrument and electrical upgrading projects in existing plants, during normal operation and having strong capabilities in electrical, instrument and civil engineering; planning and cost control; construction management and overall project management.

Due to the nature of this project, the owner of the refinery where the electrical upgrading project described in this paper is under execution, selected Wood as the EPC contractor.


## Cesare Boeri

Holding a Master Degree (MSc) in Electronic Engineering, Cesare Boeri covers the position of Senior Project Manager in the Milan office of Wood (heritage Amec Foster Wheeler).

Cesare Boeri has more than 30 years of experience in both Engineering Management and Project Management, including 17 years as the leader of Foster Wheeler's Instrument & Automation Engineering Department.

He has executed various projects from refining, chemical, power and pharma - mainly abroad - ranging from PMC to FEED to full EPC for both revamping and grass-roots installations, developing a quite peculiar experience in managing complex revamping projects with high automation and electrical content.

Since year 2011 Cesare is also covering the position of General Manager of Amec Foster Wheeler Italiana - Belgium Branch, leading the Antwerp office organisation.



## Massimo Vanossi

Massimo Vanossi is Electrical Engineering Manager at Wood (heritage Amec Foster Wheeler), with a Master Degree (MSc) in Electrical Engineering from Politecnico di Milano.

He has more than 24 years of experience in electrical engineering, 17 of which have been with Amec Foster Wheeler Italiana.

Massimo Vanossi has executed diverse projects world-wide, from refineries and petrochemical plants, to power plants and natural gas liquefaction units. He has a strong technical background and an extensive experience in FEED, EPC, PMC execution, covering all the aspects of the detailed electrical engineering, development of site works schedule, management of large electrical engineering teams, field commissioning, etc.

He is a Member of Associazione Elettrotecnica Italiana (AEI).

# More efficient power production from high altitude wind

## Saipem's and KiteGen's common goal: a great example of cooperation

**Francesco Balestrino**, Renewables & Green Technologies Product Manager, XSIGHT Saipem
**Dario Giudice**, XSIGHT Saipem
**Massimo Ippolito,** Founder of KiteGen srl
**Eugenio Saraceno,** Project Manager and System Integrator, KiteGen Project

Saipem S.p.A. and KiteGen Research s.r.l. have signed an agreement supporting the development, construction and marketing of a new technology to produce electrical power from wind. The goal is to produce power from the wind more efficiently, specifically through accessing the powerful and stable winds present at an altitude of 1000 m and more above ground level (AGL) by means of high-altitude power wings (kites), thereby favouring greater diffusion of this unlimited source of renewable energy.

### The goal is to produce power from the wind more efficiently

Indeed, the technology patented by KiteGen allows the use of high altitude wind to efficiently produce clean energy with wings connected to a generator on the ground, which, in the current design configuration, will produce up to 3 MW of power with over 6800 hours of annual availability.

The system is composed of three main parts: a giga-robot generator firmly anchored to the ground, light and resistant cables of suitable length to reach typical operating altitudes (1000-2000 m) and a power wing, which is semi-rigid, tensile-structured, and C shaped, sized to provide 300 kN of traction and characterized by an efficiency that allows the flight path to cross over 80 m/s.

Energy intensive industries, like synfuels, water desalination, mining and metal smelting, can be revolutionised by the introduction of products that incorporate tethered airfoils, aerodynamically efficient wings that have lift-to-drag ratios of ten-to-one or greater. Unless specified otherwise, these airfoils are extremely light and durable, providing traction in the range of MN forces. These airfoils have onboard power and autopilot auxiliaries for stable, remotely-controllable tethered flight. Most importantly, they provide a means of harnessing wind power to provide the mechanical power required to convert it into electricity.

The amount of power that a tethered airfoil can generate


is not simply proportional to the size of the airfoil; it is proportional to the area swept by the airfoil not only *per unit of time* but also per extension of the wind front involved, as with wind turbines, but with a much greater advantage. Even a small airfoil that quickly traverses a large area will generate significant amounts of power. Tethered airfoils can generate far more power than wind turbines, simply because they sweep a greater area for a fraction of expenditure of material and funds, since they will not incur the cost of a tower or have the blade size limitations that towers can accommodate.

This increase in performance is easily computed through Betz laws. In particular, flying wings expose a lower Betz efficiency, compensated for by the larger area swept, which allows it to outperform the energy-harnessing potential of the wind turbine blades by a factor of three, assuming equal conditions of wind speed and aerodynamic surface.

KiteGen's Giant Power Wing is the latest development from KiteGen. The complexity of this design is very similar to the typical design complexity of a new aircraft. KiteGen's design concept is a rigid C-shaped wing (C wing). The C wing is the consequence of preceding engineering advancements created by the Legaignoux brothers, inventors of the Inflatable Leading Edge, opening the potential for this new wing concept. Before this invention, the C wing had to be framed, and was unable to fly independently. It can now sustain powerful aerodynamic forces, maintaining the shape span by *actually exploiting* those same forces. The KiteGen C wing consists of 9 to 11 separate segments that are connected by flexible joints. This solution combines all the possible advantages, allowing operation in MN-class traction forces with a few hundred kg of wing weight while maintaining the flexibility required for sideslip manoeuvers.

The C wings produced by KiteGen are in place, awaiting production of the launcher robot, currently being improved for safe operation. The wings have already been submitted to extensive testing. Since there is no existing wind tunnel large enough to accommodate the wing, an innovative testing method has been adopted to assess and validate the aerodynamic efficiency (AE), the wing balance and its behaviour.

In-depth studies of cable requirements, and the fatigue factor behaviour induced by the winches, required the properties/specifications of the most innovative fiber on the market, ultra-high-molecular-weight polyethylene (UHMWPE). This fiber fully meets the design's durability and strength specifications. The generator on the ground has two closely-controlled servo-alternator lines, which operate pulleys and winches on which the cables, connected to the opposite end with the bridle wing, are wound. The generator robot incorporates an arm that keeps the C wing suspended which can be launched by exerting an appropriate amount of traction on the cables or by centrifuging the arm and the C wing until the stall speed is exceeded, ensuring a successful launch, due to the initiation of movement that provides adequate lift, even with very weak winds.

During launch, the wing gradually moves away, creating the trajectory of an "8" (lemniscate) at progressively

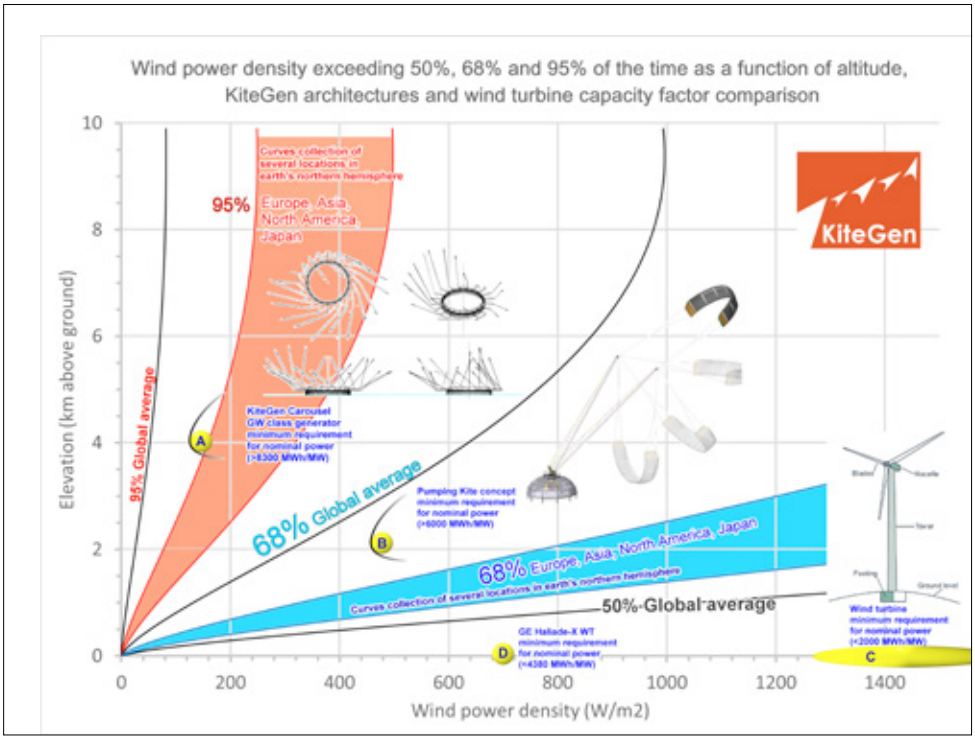
increasing speeds, rising in altitude until it finds sufficient wind (cut-in - about 4 m/s) to produce a nominal force of 150 kN on each cable. Once this force is attained, the cables operate at a speed equal to the wind speed minus the cut-in speed in order to maintain the required constant nominal force. There will then be power available in each cable equal to 150kN*Vreel-out kW (Force*Velocity=Power), reaching a nominal 3 MW when the unwinding speed "V" equals 10 m/s (wind of 14 m/s). This mechanical power is transformed into electrical power by the servo-alternators keyed onto pulleys and reels. When the cables are completely unwound, a sideslip manoeuver is performed (one of the innovations validated and claimed in patents) which allows the cables to be rewound in a differential mode (one of the two cables is kept constantly shorter than the other by several tens of metres) causing the wing to assume the shape of a flag (thanks to the property of articulated rigidity) with the loss of aerodynamic properties, minimizing the resistance caused by the latter during the recovery of the cables.

During this phase, the alternators act as servo-motors, with an energy consumption of 1% of that produced in the active phase. Once the wing has returned to a minimum altitude (programmed based on wind conditions) the length and tension on the cables is rebalanced, the wing recovers its natural arc shape and aerodynamic properties, and once more provides the necessary nominal force and mechanical power to perform further cycles. The major proprietary innovations (contained in the patents) include devices designed to optimize flight stability and control, such as radio-controlled ailerons and bridles with programmed elasticity to continuously optimize the wing's angle of attack, the exo-wing ribs that guarantee rigidity while maintaining high aerodynamic efficiency, as well as design solutions to reduce the drag of the lines, giving them an aerodynamic profile.

Other highly innovative aspects include the use of inertial platforms (an accelerometer, gyroscope, magnetometer and altimeter integrated into a miniaturized component). These devices, positioned on the wing and on the mobile parts of the ground-based generator and linked to the control unit via radio-frequency transmission, allow the computer to create accurate real-time dynamic models of the mechanical and wing parts through the application of mathematical operators and Jacobian matrices, predicting their behaviour in real time and adjusting stresses and propagation on the various parts. For example, a gust of wind that would cause a violent increase in the force transmitted by the wing through the cables, with the impulse propagated along the cables at the speed of sound, would be detected by the accelerometers and transmitted to the ground *at the speed of light* to allow the ground unit to respond appropriately. This creates stability of control and dampening, e.g. prompt reel-out of the cables to neutralize the incoming impulse.

## The advantages of this technology, compared to conventional wind turbines, are manifold

The advantages of this technology, compared to conventional wind turbines, are manifold. In fact, high altitude wind is virtually omnipresent (over 8,000 hours a year) and has a higher and constant speed (on average 15 m/s or 1.6 kW/sq. m), with a much higher capacity. It is a solution to the problem of the discontinuity of the wind source currently undergone by wind turbines. The structure of the kites is much lighter, entailing relative and significant savings from the CAPEX and OPEX of the investment. This reduces the cost of the power produced, guaranteeing access to clean energy to a greater number of users. Finally, the generators can be positioned at a shorter distance from each other than traditional wind turbines: consequently, there is a greater production of energy while taking up less space. Moreover, with respect to conventional wind turbines, with the KiteGen design there is no dramatic limitation of scalability from the "square cube law" that afflicts wind turbines and this will allow the system to evolve with hundreds of nominal MW,



even with a single wing, with the appropriate structural adjustments and advanced materials.
KiteGen has been at the forefront of the industry and has been a pioneer in the production of energy from kites since the early 2000s, with research prototypes, and has since taken as its objective the study of a machine on an industrial scale that, after fulfilling all the research issues (theoretical, architectural and the consistency of the resource), has directed work toward defining the articulated technology.

**KiteGen has been at the forefront of the industry and has been a pioneer in the production of energy from kites since the early 2000s**

Saipem has chosen to support the KiteGen solution, based on in-depth assessments of the aforementioned strengths of the former; in particular, the choice was influenced by the fact that KiteGen has patented valid deep offshore architectures of tropospheric wind (which are of particular interest to Saipem), which offer light and safe structures, and that the solutions adopted by KiteGen have been protected through appropriate patents and patent applications in a large number of countries.
The unique properties of the systems implemented by KiteGen to manoeuver and control the wing used for the production of energy (wing release and recovery systems, light and high resistance cables, advanced automation and control systems), match with the proprietary knowledge Saipem has acquired in carrying out conventional business activities in deep waters, on the one hand accelerating the industrial development of technology and, on the other, searching for new fields of application for the technology itself.
There are several applications for the KiteGen technology, including:

1. Onshore applications, including the use of abandoned nuclear power stations or polluted terrains (landfills etc.).
2. Offshore applications, including the repowering of existing wind turbine foundations, and the decommissioning of oil & gas offshore platforms by reusing the support structures of the platforms.
3. Offshore application on floating foundations, the lighter structure of the KiteGen solution will allow a considerable reduction of CAPEX;
4. Hybrid solution: integration with other existing facilities to increase the plant's efficiencies or to obtain other advantages from the low cost energy availability (i.e. production of clean H2, desalination plants, etc.)

Among the possible applications of KiteGen technology, Saipem is working specifically on its possible offshore application as, due to its lightness, the system can also be implemented in deep water.

## Francesco Balestrino

Francesco Balestrino owns a Master degree in Mechanical Engineering. Having started his career within Saipem Procurement in 2003, he's currently a Senior Manager with more than 12 years' experience in project management having covered several relevant roles as, for instance, Project Director of Kashagan trunklines installation Ersai, Castorone Vessel Operation Manager and more. Since May 2017 he's Saipem XSIGHT Renewables & Green Technologies Product Manager.

## Dario Giudice

Dario Giudice owns a Master degree in Naval Architecture and Marine Engineering an MBA in Oil & Gas Management and a Major in Energy. He has been working with Saipem since 2004 performing complex installation analysis of various structures in the sea, both in shallow and deep water. He joined XSIGHT Renewables & Green Technologies product line at the end of 2017, where he's dedicated to wind energy, an area where he started gaining competences since 2015.

The lightweight characteristics of the KiteGen design will also allow Saipem to offer its customers hybrid solutions that integrate the production of high-altitude wind electric power with traditional solutions in the O&G sector with the aim of:

1. Providing a solution for the carbon neutrality;
2. Improving energy efficiency and affordability;
3. Increasing the use of non-intermittent renewable energy.

**KiteGen design will also allow Saipem to offer its customers hybrid solutions**

KiteGen's technology has the capacity to meet the needs of the global electrical power market fully, guaranteed by a natural "field" with a potential hundreds of times greater than human needs, with no adverse effects on weather patterns or global climate (ref. Ken Caldeira, Stanford University). The low capital cost of the generator and the fact that the maintenance cost is reasonably proportional to the energy produced is a positive sign that the technology will have a beneficial dampening effect on energy prices for industrial needs and on retail electricity prices.

This would favour restoration of the industrial ecosystem and the creation of new businesses currently restrained by high energy costs, which would benefit from the sustainability offered by this unprecedented source of *abundant clean* energy. These possibly include heat pump air conditioning, synthetic fuels (which are carbon neutral, produced by CO2 captured in the atmosphere or in the oceans) and the electrical processing or synthesis of many materials, including metals and polymers. Other possibilities favoured by low-cost renewable energy are electric cooking (for example, induction), the regeneration of batteries for mobility, jet fuel, electro-foundries, metal smelting, metal forming, silicon refining, water desalination, fertilizers, etc., also stimulating second and third-tier industrial sectors. This potential low cost of energy

## Massimo Ippolito

Massimo Ippolito, founder of KiteGen srl in 2007.

Prior to this last entrepreneurial activity, he has a long list of inventions and start-ups from the development of the first free broadcast transmitters in Turin in 1975, then to the foundation of Sequoia Automation in 1983. Over its life worked that company has worked on over 100 projects including: human voice print recognition, detection of leaks in pipings on vibrational signals, artificial vision for quality control, industrial acoustic selections, control and realization of robotic parallel kinematics, EHV grids service robots, Turbo-gas generators control, autonomous energy systems and vehicles. In 1985 he was awarded a major contract from FIAT Aviation Division for the creation of an automatic system for the bearings mounted on boxes to Eurofighter Tornado gear according to the stringent specifications of MIL procedures. In 1998 started the production of the SeTAC series, a device "SEQUOIA Triaxial Acceleration Computer" alongside several R&D EU founded projects. In 2002, the novel features of motion tracking in three-dimensional space of SeTAC instrument, intelligent acceleration sensor designed in Sequoia automation have led to the idea to develop an application in the renewable energy field, the Kite Wind Generator, which aims to build the high-altitude wind to produce electricity, whose prototype was conceived in 2005.

## Eugenio Saraceno

Eugenio Saraceno - Since 2013, Project Manager and System Integrator, KiteGen Project, where he is responsible for the System Integration and Architecture, relationships with partners and cooperation.

Earlier, he was the Senior Project Manager at Central Bank of Italy (2012),

Senior ICT Consultant at Telecom Italia S.p.A. and Wind Telecomunicazioni S.p.A. 2003-2011, Software Manager at SIRTI S.p.A. (1999-2002), Software engineer at Eustema S.p.A. (1998).

Following the Master's Degree in Computer Engineering in 1997 at the University of Rome Tor Vergata, he obtained a Post-Graduate Master degree in Energy Resource Management from SAFE, Rome.

could give access to markets other than that of electrical energy, such as transport and civil and industrial heating, now dominated by hydrocarbons, and the respective industrial sectors.

This innovation is in the domain of mechatronics/aerospace, and the most innovative element with respect to the state of the art is certainly the C-wing. The availability of an instrumented and implemented power wing is the principal enabling and exclusive factor for large-scale generation of cheap energy from tropospheric wind. The concept of a wing capable of such great power production is new. The laboratories around the world that have successfully reproduced the KiteGen tropospheric wind generator have shown an energy production and limit of a few dozen kW, due to the use of inadequate sport kites. KiteGen conducted research on the wing at a very early stage, essential in order to reach utility scale, achieving performance at least one hundred times that of small-scale systems that produce expensive energy and have no path to incremental scalability.

KiteGen therefore represents a qualitative advancement, enabling the development of a new economic sector of tropospheric wind energy, made possible by megawatt-class generators. Moreover, the modular design or, more simply, the kite wind-farm concept, could even be scaled up to compete with the broader sector of the energy market.

A viable alternative to the KiteGen Stem Farm is the KiteGen Carousel, which does not need reciprocating cycles; rather, it maximizes productivity and is capable of harnessing even weaker winds.

From an installation point of view, the KiteGen design promotes the deployment of light generator systems (less than 20 tons), which can be positioned at close distances to each other, since the flight of the wings can be tightly controlled with an error maximum of +/-10 m, occurring in relevant cones that move in formation. The generators are paralleled on a 1000 VDC-Buss and share a storage system sized to avoid drawing energy from the network during the passive phases of the production cycles and to provide an energy reserve which, in the event of a grid disconnection, allows it to bring all the wings back to the ground safely and temporarily shut down the plants. Maintenance is much simpler than that of a wind farm and only involves periodic preventive maintenance to replace wings and lines, considered to be consumables, and good preventive and proactive practices, such as lubrication and monitoring which, thanks to the considerable number of sensors on the machinery, can be monitored remotely and even predictively applied.

The piloting, in analogy with aircraft, is available in both manual and automatic mode, where the automatic mode is based alternatively on parallel fluid dynamic calculations or artificial intelligence.

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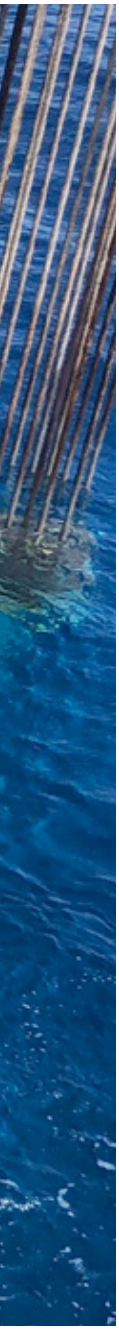
# Valves for critical applications in the oil and gas industry

Meeting the ever increasing challenges of high depths, hostile ambient conditions, corrosive fluids

**Enrico Sanguineti** - General Manager
**Niccolò Sanguineti** - Special Projects Engineer
Advanced Technology Valve Spa



The Oil & Gas industry is continuously pursuing the exploration and development of resources in remote locations previously not accessible and in extreme operating conditions previously not manageable.

Water depths below three thousand meters, arctic ambient conditions, very high pressure in excess of one thousand bars combined with temperatures in excess of two hundred degrees and produced fluids with high content of corrosive elements.

All these are the elements of the challenge that the Oil Companies face more and more frequently and share with the manufacturers of equipment and the constructors of production and processing plants.

Associated with the technical challenges comes the highest focus on safety, on the protection of the environment and, last but not least, on the fast-track execution – now the norm - and on the cost reduction!

## Valves for critical applications are highly engineered to the specific project and are developed and qualified in close cooperation with the customer

Valve manufacturers face the same challenges and have to respond with products and execution strategies that can meet the requirement and expectations of the customers and, Advanced Technology Valve Spa (shortly ATV), an Italian manufactures of valves for critical service, is at the forefront in such mission.

In the most of the cases, valves for critical applications are highly engineered to the specific project and are developed and qualified in close cooperation with the customer.

With the aim to survive in the harshest conditions and provide a maintenance-free life in oil and gas production systems and pipelines both subsea and above the water and onshore, engineered valves for critical applications feature similar details.

Typically, these valves are forged, metal seated with tungsten carbide HVOF coatings to avoid damages from debris and with inlay in alloy 625 on the sealing surfaces to ensure that valve will last in corrosive environments.

## Large bore high pressure valves for HIPPS and Emergency Shut-Down Systems

Deep hydrocarbon reservoirs entail high well pressure and temperature and, in some cases, also corrosive and poisonous well fluids, containing high content of H2S.

In the development of high-pressure fields, it is technically beneficial to adopt High Integrity Pressure Protection Systems with the aim to reduce the thickness of the piping on the flow-lines and process, and avoid the implementation of expensive flare systems.

ATV, with its dedicated division ATV HIPPS, has been involved in the supply to NCOC, a consortium of major oil companies in Kazakhstan operating the Kashagan field, of a number of turn-key integrated HIPPS systems with large bore slab gate valves 18" API 10,000, rated for 69 MPa design pressure.

The HIPPS valves for Kashagan are capable of withstanding corrosive gas with up to 33% of H2S and to close fast in less than five seconds in order to protect the line from excessive pressure.

These valves have a forged body in low alloy F22 for the highest integrity, are fully cladded in alloy 625 and are metal seated with tungsten carbide HVOF coating on the gate and seats built in integral 718 superalloy.

An extensive qualification program according to the most stringent international and oil company specific standards inclusive of API 6A PR2, fugitive emission testing and full scale fire-safe has validated the design for the unique service.

It is worth to mention that the Factory Acceptance Test carried out on each valve requires a high-pressure gas test with nitrogen and no bubbles are allowed during such high pressure test.

The same gate valve 18" API 10,000 has more recently

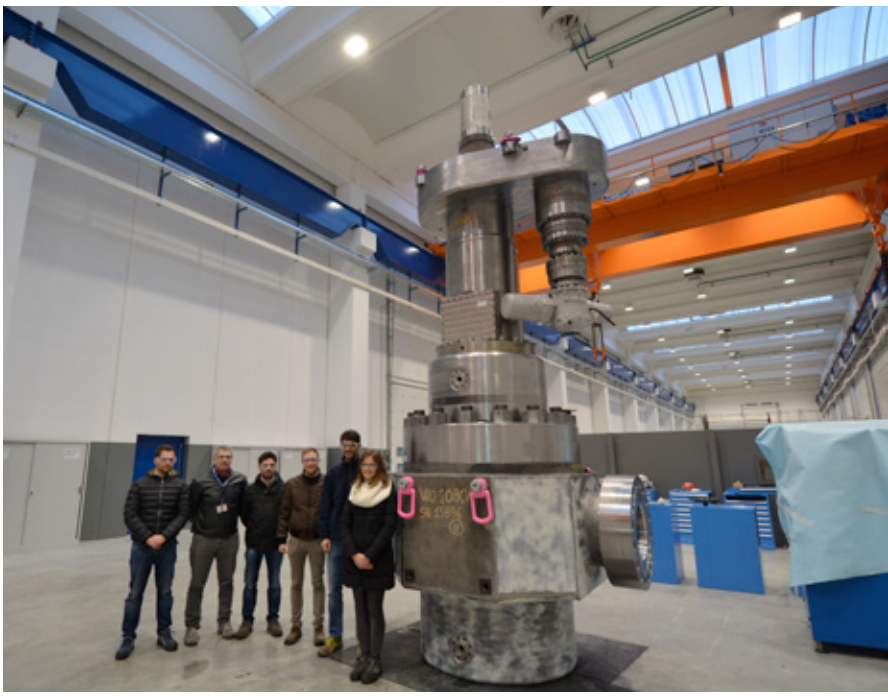
delivered to a major offshore gas field in the Mediterranean to serve as Emergency Shut-Down Valve on the main export riser.
In this case, the main challenge was represented by the limited space available and leading to the decision to install the valve in an horizontal orientation.
A tailor-made very compact actuator was developed and qualified for the application with special tools required to allow the maintenance in the horizontal position.
Again, a case of a unique tailor-made solution developed and delivered to the customer in less than thirty weeks.
Another example of a tailor-made solution is the delivery to Lundin, an independent operator in Norway of a large bore ball valves 30" ANSI 1500 Emergency Shut-Down Valve designed to be installed in a vertical riser pipeline and fitted with special features to allow the in-line maintenance of the valve.
The valve has been FAT tested in the same vertical-pipe orientation, then the full sequence of disassembly and reassembly - required during maintenance - has been performed.

## Boarding shut-down valves for the Gulf of Mexico after Macondo

Additional and more stringent regulations have been implemented in the Gulf of Mexico by the American authorities after the tragic Macondo well blow-out to further reduce the risk and potential consequences of offshore accidents.
Particularly relevant to the oil operators is the introduction of a new category of valve, the riser Boarding Shut-Down Valve (shortly *BSDV*) and the related very stringent regime of monthly leak testing with a strict acceptance criteria of no visible leakage.
Accepting the challenge and the request of the customer to address a changed regulatory environment, ATV has delivered to the Gulfstar platform operated by Williams, an independent offshore mid-stream operator, two complete BSDV trains: each one included two main gate valves 7" API 15,000 (1038 barg design pressure) operated by fail safe close compact actuator, and a 2" by-pass system.
BSDV valves are part of a separate emergency shut-down system independent from the normal ESDV and add one additional safety layer to further reduce the risk of major accidents.
The valves delivered are successfully in operation since 2016.

## Large bore double expanding gate valves for bubble-tight isolation

Pipeline systems are generally provided with provisions to run pigs, essentially devices capable of cleaning the line and, in the case of smart pigs, to perform diagnostic verifications on the integrity of the pipe with



non-destructive examination and measurement of the residual wall thickness.
Pigs are launched and retrieved with pig launchers and receivers fitted with isolation valves that are required to fully and reliably exclude the line pressure from the pig barrel when the hatch is opened to the atmosphere.
Trunnion mounted ball valves to API 6D standard are typically used for this service but in high pressure gas applications double expanding gate valves may be preferable where the highest requirements of positive tight shut-off and double barrier isolation apply.
This is the case of a major green-field gas project offshore development in the Mediterranean where ATV has delivered a number of large double-expanding gate valves 18" API 7,500 psi with electric actuation.
The valves are with a forged body design in low alloy steel F22 to achieve the required mechanical strength and are cladded with alloy 625 on the sealing surfaces to avoid any risk of corrosion.
A special electric actuator was developed to operate the valve with a linear force in excess of 5 MN.

## High pressure subsea valves for the Gulf of Mexico

Subsea developments in the Gulf of Mexico are particular challenging for the extreme operating conditions – water depth, pressure and temperature often combined together.
Shell Appomattox, a project recently developed, represents a very interesting case where subsea top-entry ball valves 7" API 15,000 were designed and qualified to operate at 1034 barg and 200 degrees Centigrade at 2000 meter water depth to the requirements of very stringent new industry standard API 17TR8, introduced to cover the high pressure high temperature service conditions.

**In the development of high-pressure fields, it is technically beneficial to adopt High Integrity Pressure Protection Systems with the aim to reduce the thickness of the piping on the flow-lines and process, and avoid the implementation of expensive flare systems**

The qualification program has included extensive cycling also with temperature, high pressure gas test and hyperbaric test at ATV test facility to verify the valve performance at the bottom of the sea during a period of several months.
The next fields to be developed in the Gulf of Mexico

will pose even greater challenge to the oil companies and to the equipment manufacturers with design pressures up to 139 MPa (20,000 psi) and temperatures up to 175 degree Centigrade.
Certain products are already available to cope with these extreme conditions with valves 5" and 2" already qualified by ATV, and on-going qualifications to extend the range of sizes also to 7" valve.

## Ball valves for subsea pipeline – designed to last

Subsea oil and gas production systems and gas pipelines rely on valves for the isolation during the commissioning and in operation.
Valves delivered for subsea pipelines are designed to be maintenance-free for the design life of the pipeline installation, that in certain cases exceeds forty years, and to withstand - in addition to the external water pressure - also the high piping loads during installation when the full weight of the pipe catenary is temporarily supported by the valve.
Such loads can be very high with pipelines installed in deep-water and lead to extensive verifications of the valve design with FEA structural analysis and structural bending tests.
In the specific case of the picture shown in the first page of the article, an ATV subsea ball valve 18" API 7,500 , is shown on the stinger of a pipe-laying vessel during the installation campaign in the Mediterranean Sea.

## State-of-the-art technologies in design and manufacturing

In order to meet the requirements of performance and integrity and the expectations of the customers in terms of quality and on-time deliveries, ATV relies on a state-of-the-art facility and adopts the most advanced technologies for the production of the components and their final assembly and testing.
The development of valves for critical applications entails a wide range of technical disciplines, spanning from structural FEA modelling to material, welding and NDE engineering with highly qualified engineers.
Particularly relevant are also the in-house machining and welding facilities, and the NDE capabilities with advanced inspection including Phased Array Ultrasonic Inspection and Acoustic Emission.
The engineered valve industry is ready and fully committed to meet the challenges set by the development of fields in extreme environmental conditions working and in close cooperation with the End Users and EPC Contractors.


## Enrico Sanguineti

Enrico Sanguineti - General Manager with Advanced Technology Valve Spa. Enrico has a master degree in Mechanical Engineering with the University of Genova and twenty-five years' experience in the engineered valves industry.



## Niccolò Sanguineti

Niccolò Sanguineti - Special Projects Engineer with Advanced Technology Valve Spa. He earned a master degree in Civil Engineering from Politecnico of Milano. After graduation, he joined ATV in 2015.

# Cannon Artes designs and builds a modular water treatment plant for Turkmenistan

## A major contribution to Garabogaz Fertiliser, the biggest Ammonia Urea Plant in Turkmenistan

**Alessandra Leni,** Corporate Marketing Manager, Cannon
**Alessio Liati**, Sales Director, Cannon Artes
**Giulia Sporchia,** Proposal Engineer, Cannon Artes

Turkmenistan's economy is based on hydrocarbons, in particular on gas. Hydrocarbons make up 25% of the Country's GDP and it is the main export asset, most of which is natural gas transferred to China. The hydrocarbon exports and the trade balance are strictly related to the crude oil price and to the Chinese gas demand. The Country is 4th in the world in estimated gas reserves, which account for about 10% of the global reserves. Furthermore, many new gas fields have been recently discovered and developed.

The above issues push the government to grow further other gas export markets, such as Europe, and to look for new ones: the new Caspian pipeline, that would carry gas to Europe, and the Turkmenistan-Afghanistan-Pakistan-India gas pipeline are some examples.

Other governmental actions are the diversification of exports, offering higher value goods and bolstering at the same time the internal industrial production to better the living conditions of the population.

The huge gas availability has been a starting point to provide the feedstock to the petrochemical industry.

In particular, the Government has been expanding the production of various types of fertilizers to ensure the food security of the Country: the fertilizers produced in the Country will increase by 1.6 times and will amount to 3,825,000 tons in 2024, when 74.5% of these products will be exported.

Since the GDP of Turkmenistan has been growing in the last years at the rate of +6%/y, all these new initiatives will make the economy grow even faster in the near future.

## Turkmenistan Garabogaz Fertiliser plant

The Turkmenistan Garabogaz Fertiliser plant (TGF), developed by Turkmenhimiya, the chemical state-

owned company, is one of the first new mineral fertilizer production complexes centered around a huge ammonia plant.

Once in operation, 700 full-time jobs are assured, for a daily production of 2,000 tons of ammonia and 3,500 tons of urea. The feedstock of the plant is gas: one billion cubic meters will be used annually.

Located very close to the Caspian Sea, it has been commissioned in September 2018 and in December of the same year the first export cargo was delivered to Italy and to Spain.

The project has been carried out on the EPCC basis by the consortium between Mitsubishi Heavy Industries - MHI, GAP Insaat and Mitsubishi Corporation - MC. MHI and MC were responsible for the design, procurement and commissioning of the plant.

MHI with 83,000 employees is an industrial giant involved in very diversified sectors including chemicals, fertilisers, power generation, infrastructure, aircraft, defence and space.

**The production of ammonia and urea from natural gas involves an intensive use of steam to feed the reforming process and the use of water as a cooling vector in cooling systems**

The production of ammonia and urea from natural gas involves an extensive use of steam to feed the reforming process and the use of water as a cooling vector in cooling systems.

Many plant utilities need water, as potable water for human use, irrigation water and firefighting water.

As an output there are many streams such as steam condensates contaminated with oil products and salts and process condensates contaminated with ammonia and ammonium nitrates.

So water is an important topic related to the performance of the process, to the state of the equipment and to the environmental issues.

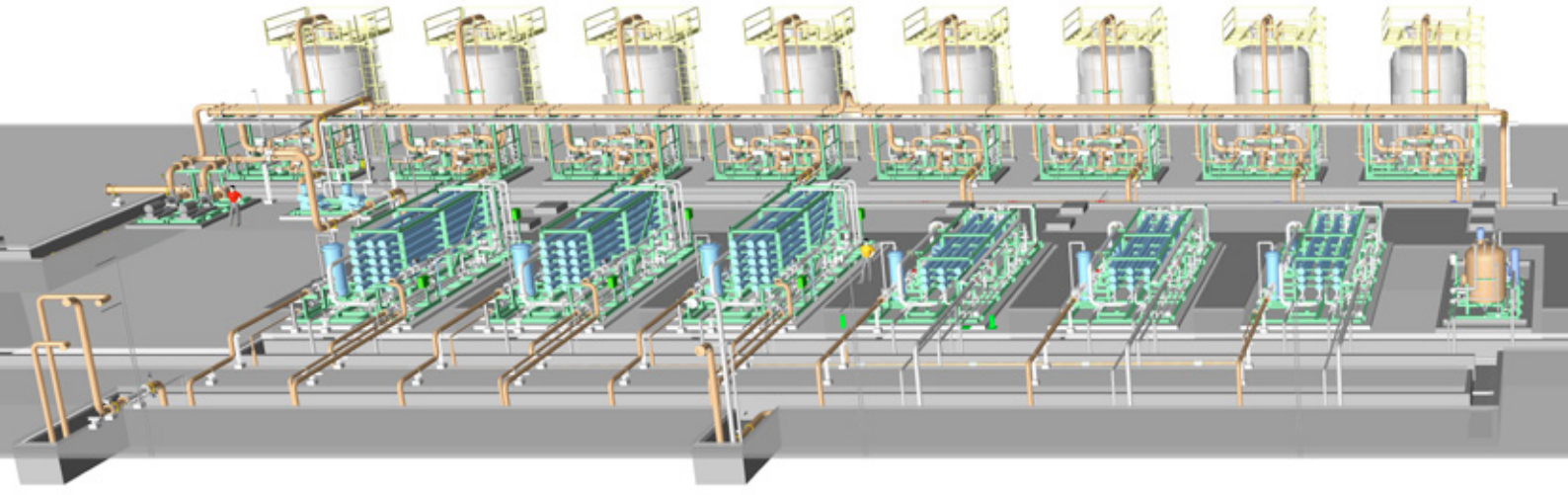
## Collaboration between MHI and Cannon Artes

Mitsubishi Heavy Industries choose Cannon Artes as partner for the design, manufacturing and installation of the water treatment facilities involved in Garabogaz Fertiliser plant.

A strong point of Cannon Artes taken in consideration was its previous experience in the fertiliser sector and in particular the supply to the Qafco Project in Mesaieed – Qatar, where recovery of waste-water was achieved with the implementation of a Zero Liquid Discharge philosophy.

**A strong point of Cannon Artes was its previous experience in the fertilisers sector, in particular the supply to Qafco Project in Mesaieed – Qatar, where recovery of waste water was achieved with the implementation of a 'Zero Liquid Discharge' philosophy**

The TGF water treatment plant, commissioned at the beginning of 2018, was installed in a 10,000 sqm building: 170 meters long and 60 meters wide; it covers an area which is about 1.5 times a football field! In one single place are collected all the water treatment processing units, composing a fully integrated system whose performance are guaranteed by a one single supplier that had the opportunity to optimize the water treatment process, proposing a high performing competitive solution.



Modularization and process optimization drove the engineering carried out by Cannon Artes technicians; this optimized in house manufacturing (materials and time) and on site assemblies activities reducing the capex.
Prefabrication has been implemented to the maximum extent to reduce on site activities in a very remote area, far from the major transport routes.
The modules, of 7,800 cu.m. overall volume, were prefabricated in the Cannon Artes workshop (Oliveto, Southern Italy) and then shipped to Garabogaz.

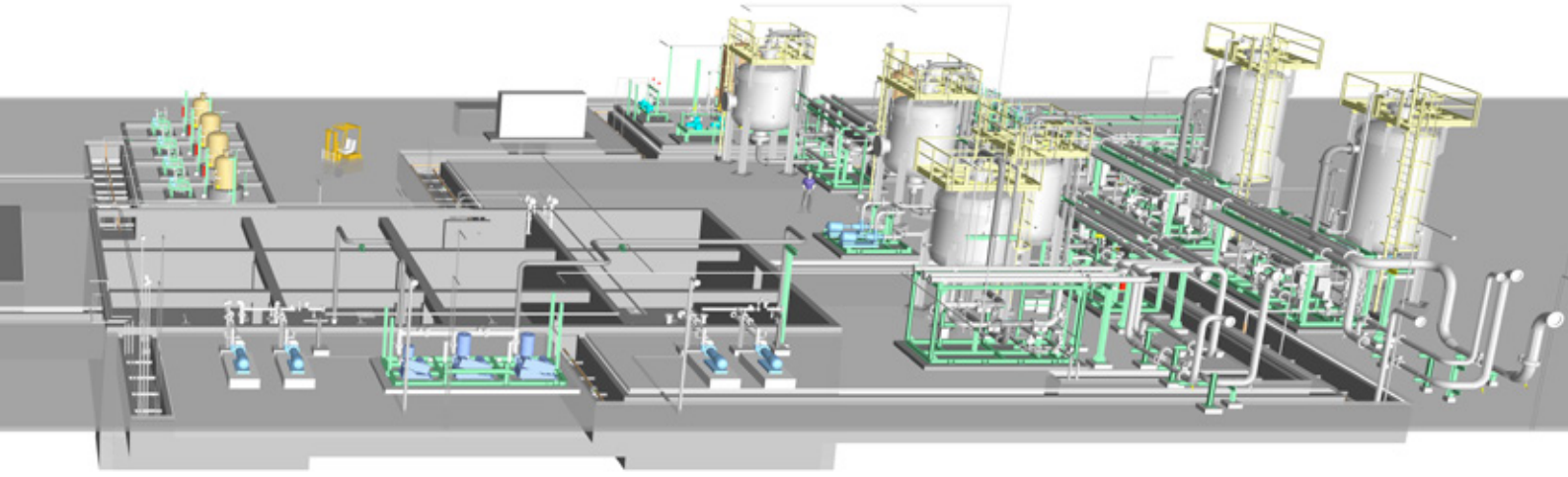
**The modules, of 7,800 cu.m. overall volume, were prefabricated in Cannon Artes workshop (Oliveto, Southern Italy) and then shipped to Garabogaz**

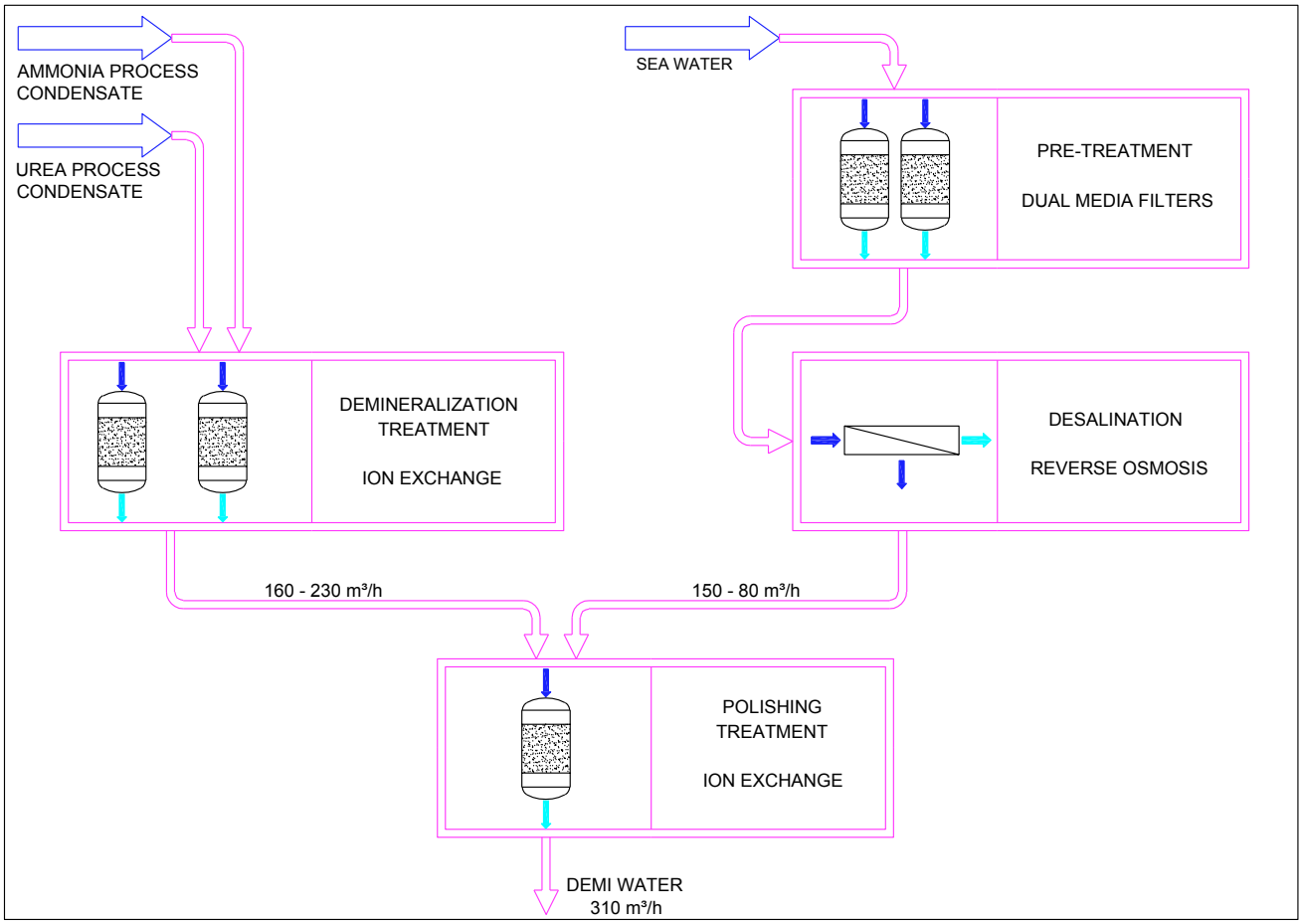
The prefabrication took into account the difficulties of transportation from Europe to the Caspian Sea in particular considering the accessibility of the Volga-Don channel.
The quantity of chemicals used during the operation of the plant are reduced as well as the amount of water discharged by the waste water treatment system, so few new fresh water is required to make up the "closed water cycle".
Another opex saving was related to electric energy consumption: rotating equipment are equipped by innovative multilevel inverters providing a very effective modulation.
The inverter varies the frequency and the voltage supply of the electric motors, fine-tuning their speed to the actual needs of the pump.
From the data received from the field an effective 35% of energy savings has been recorded, compared to the on-off system.

## The Water Treatment Process

The fresh water is taken from the salty Caspian Sea and has to be treated to provide different utilities and the high pressure steam boilers that are very demanding with the feed water quality to keep the thermal performance high.
A relevant issue that was duly taken into account in the design stage was the accurate selection of materials, as the presence of seawater results in a highly corrosive environment, due in particular to the chloride content. The presence of nitrogen compounds involved in the fertilizers production, suggested not to use copper alloys which are normally applied in particular in-sea water applications.
As a consequence carbon steel coated with glass flake, duplex steel, polyester reinforced glass fibre and aluminium were used.
How to reach the requested quality of water starting from high salinity sea water?
In between there is a "smart" combination of different multi stage processes carried out by different technologies: pre-treatment, desalination, demineralization and condensate polishing.
The raw and process water treatments are integrated with the waste water treatments to reduce water consumption of the overall system: treated waste water returned from some utilities is used as part of the feedstock to the process water.
The capacity of the water treatment plant is 7200 cu.m./day which is achieved by maximizing recovery of return condensate and making up with desalinated water from the reverse osmosis system. The plant must be therefore flexible to manage a range from 0 to 230 cu.m./h of the return steam condensate from the process.

In the **pretreatment section**, seawater, after mixing with coagulant and hypochlorite, is sent to dual media






filters arranged on a double pass with different filtration rates.
Filtered water is then mixed with antiscalant and dechlorination agents and is fed to cartridge filters prior to reverse osmosis system.

The **desalination** plant is definitely crucial for the TGF complex: the water necessary for the process and utilities is taken exclusively from the Caspian Sea and treated to produce boiler feed demineralized water through several steps.
Desalination is achieved with Reverse Osmosis (RO) technology where water is pumped across semipermeable membranes, permeable just to salt-free water.
Since the seawater is a "live" environment, rich with algae and microorganisms, the design of the system had to take it into account, thus a key point in seawater desalination is the pre-treatment designed to prevent the fouling of the reverse osmosis membranes.
Due to its high salinity seawater, it has to be pumped at high pressure, about 70 bar, in order to win the osmotic pressure and to achieve in this way an acceptable recovery of the water itself.
To manage the high pressure and the large capacity, medium-voltage electrical motors and variable frequency drivers (VFDs) are implemented; this assures the optimization of the operational efficiency with the actual required flow.

Two kinds of condensates coming from the ammonia and urea processes respectively are fed to the **demineralization** system for removal of residual ions. Such system is arranged on two trains based on cationic and anionic exchangers.

Cannon Artes' scope of supply also included **the complete regeneration system** of the ion exchangers which consisted of sulphuric acid and caustic soda handling facilities (tanks, dosing pumps, regeneration pumps and dilution system). The regeneration system is targeted to the minimization of chemical consumption and to the achievement of neutralised effluents.

**Polishing** is the last step for the water treatment system. Before feeding the boilers, the demineralized water coming from demineralization section is mixed with the deionised water coming from the reverse osmosis section and undergoes a further treatment with mixed bed exchangers to remove traces of ions and reach an electrical conductivity close to that of theoretically pure water. Dissolved silica is reduced to just a few parts per billion.
Quantitative removal of all dissolved salts is mandatory in order to comply with the strict specifications applicable to high pressure boilers.

Cannon Artes' supply for TGF also included the **waste water treatment plant** for the whole complex, collecting all the waste streams from the process, the rain water and the sewage. The main issue is the oil removal before discharge. This had been achieved by a de-oiling system based on corrugated plates interceptor to remove oil and suspended solids from the contaminated rain water and a neutralization system capable to adjust the pH before discharge.

In conclusion, Cannon Artes developed all the engineering and execution of this system that involved 10 different technologies, using internal competences in all the expertise areas involved: process, mechanical, electrical, automation and control, equipment fabrication, assembly, installation, commissioning and startup. The plant was manufactured, pre-assembled and tested in the 40,000 sq.m. Italian factory.

## Alessandra Leni

Alessandra Leni - Responsible for the marketing, communications and digital marketing activities at Cannon Group Corporate level.
She graduated in Management Engineering at Politecnico di Milano. After an experience in Confindustria, where she had managed for 8 years the Italian Association of boiler and pressure equipment, she worked in Walter Tosto as business developer and key account manager for the EPCs contractors and End Users in Northern Italy that are active in the petrochemical and power generation industries. She joined Cannon Bono Energia in 2011 to develop the marketing activities for the industrial boilers and water treatment businesses.

## Alessio Liati

Alessio Liati - Sales Director of Cannon Artes
He graduated in Chemical Engineering in 1994 at the Politecnico di Milano, with the specialization in chemical plant designs.
After an initial experience as process engineer, in 1998 he joined Artes Ingegneria, a Company involved with Water & Waste Water Treatment technologies, where he supported the creation of the Oil & Gas Division and the expansion through technology acquisitions of the upstream and downstream sectors.
Throughout more than 20 years of experience he promoted Artes' global expansion with supplies to the major National & International Oil Companies.
He is a member of the steering committee of the Packages Section of ANIMP, the Italian Association of Plants manufacturers.

## Giulia Sporchia

Giulia Sporchia - Graduated in Environmental Engineering in 2011 at the Politecnico di Milano, in 2012 she joined Cannon Artes where she is responsible for the engineering and the process design during the proposal stages. As part of the R&D team she implements new technical solutions within Artes' portfolio of technologies.


# Maire Tecnimont Group's Green Acceleration Challenge

The launch of NextChem, the new company dedicated to supporting the energy transition

**Carlo Nicolais,** Head of Institutional Relations and Communications, Maire Tecnimont Group

*A moment of the NextChem event at Maire Tecnimont's HQs in Milan*

The energy transition in progress is driving the energy industry to invest in the exploitation of sustainable sources and in the conversion of already existing technologies – and in the development of new ones – to obtain processes with less environmental impact, and to realize new eco-compatible products. In this new energy paradigm, the main players in the sector, both producers and buyers of plastics, are moving towards recycling and bioplastics, while the big oil companies are reviewing their investment plans in terms of decarbonization.

Hence, in order to respond to such a scenario which is evolving at increasing speed, Maire Tecnimont Group kicked-off its Green Acceleration project through the launch of NextChem, its new company dedicated to supporting the energy transition. A sector that today has an annual turnover of around 40 billion dollars in the world, with a growth rate of over 15 percent. The goal, as Maire Tecnimont **CEO Pierroberto Folgiero** stressed, is ambitious: *"We don't want to be caught unprepared in a world that is moving towards decarbonization. It is the right time to enter the field by applying our skills in technology and plant engineering. Our idea of innovation involves the development, industrialization and marketing of new solutions that derive from validated technologies"*. Indeed, following the principle of low capital intensity, collaborations and scouting, Maire Tecnimont is able to bridge the gap between the idea born in the laboratory and production on an industrial scale.

## The on-going energy transition is directing the energy industry to invest in the exploitation of sustainable sources and in the conversion of already existing technologies to obtain processes with less environmental impact, and to realize new eco-compatible products

The dedicated vehicle - NextChem - is managing a portfolio of several technological initiatives attributable to three macro areas, which represent the main emerging trends for the immediate future. *"Greening the Brown"* activity aims at mitigating the environmental effects of the technologies used for the transformation of oil and natural gas. We are talking about innovations which apply to traditional petrochemical solutions, aimed at limiting or eliminating CO2 and other greenhouse gas emissions released from existing plants. Zero emissions desulfurization technologies or chemical fertilizer coating to avoid ammonia dispersions are some of the projects currently being implemented.

*"Circular Economy"* is focused on the implementation and further optimization of the recycling of plastic and other waste materials. Namely, a way to regenerate existing plastic, thus avoiding environmental impacts: from the mechanical and chemical recycling of plastic materials to regenerate polymers up to the waste-to-chemicals technologies which could produce renewable gas, hydrogen or any traditional chemical from the gasification of wastes.

## Developing an economic model for energy transition, focused on recycling and bioplastics, reducing the carbon impact. The green acceleration of the Maire Tecnimont group is called NextChem

Finally, *"Green-Green"* is the innovative area with which Maire Tecnimont group aims to identify additives or oil substitutes to produce fuels and plastics from renewable sources. Carbon is the source of vital energy and can be found not only in hydrocarbons, but also in sugar and cellulose for example. Chemistry and Biology will cooperate in this respect, leveraging bacteria and enzymes. It is the time for Biofuels and Bioplastics from Biomasses.

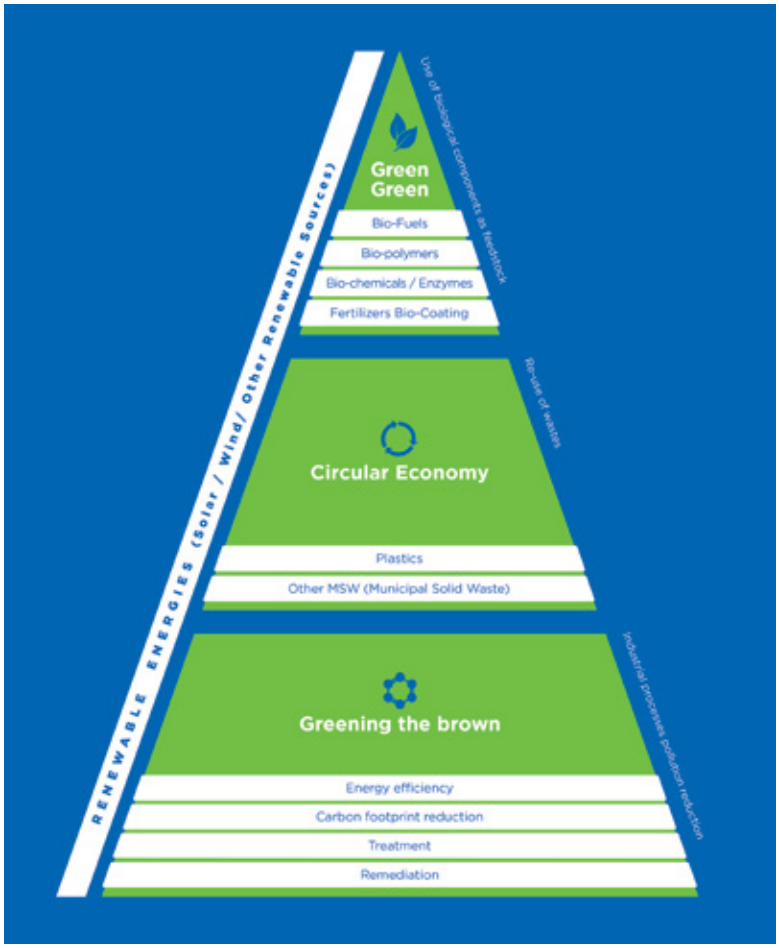
*From left to right: Fabrizio Di Amato, Maire Tecnimont Group Chairman and Founder, and Pierroberto Folgiero, Chief Executive Officer*

Over the past five years Maire Tecnimont Group has invested around 50 million euros distributed over 70 innovative projects. With NextChem, the goal set is to reach ambitious economic goals: a big challenge and a progressive path, with the objective to creating value for all shareholders.

## NextChem three-pillar strategy to tackle market challenges: Greening the Brown, Circular Economy and Green-Green

For Maire Tecnimont it is a turning point in some way, which has its roots in the chemistry of polypropylene (discovered by the Nobel Prize winner Giulio Natta) but which is strongly committed to making a difference in the present, positioning itself strategically for the energy future, as **Maire Tecnimont Chairman Fabrizio Di Amato** pointed out during NextChem's event: "*Green chemistry is a very topical issue, and what is happening in the world in this segment is a great opportunity for our group: this challenge has the flavour of technological innovation and precedes the evolution of the energy market.*"

*Fig. 3: The three areas of activity entailed in NextChem's strategy.*




Green Acceleration means first of all to be aware of what is missing and to build it. It means helping all the players in the supply chain to grow a new identity, redefining the roles of large companies, universities, start-ups and finance. Thanks to its technological DNA, and its leadership in the transformation of natural resources, Maire Tecnimont is today able to act timely, to be the technological and industrial partner in the energy transition under way. As part of this strategy, Maire Tecnimont already announced an agreement with Enea in the field of energy transition. A synergy in green chemistry and the circular economy, extended also to international actors specialized in renewable energy.

Maire Tecnimont is, therefore, best positioning itself to contribute to accelerating the launch and commercialization of innovations, transforming good ideas into industrial plants, also thanks to a strong experience in technology and a solid engineering tradition in the execution of projects. In managing the technology portfolio, the Group can play the role of competent intermediaries who, within an ecosystem, seek capital for the realization of the best projects: a quality partner for those who want to make innovation, for those who want to make it flourish and become concrete outside the research laboratories.

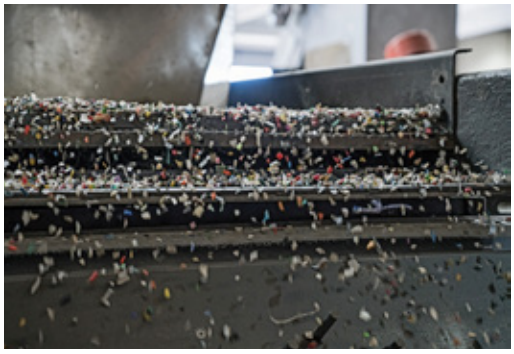
**Technologies for the energy transition:** the MyReplast Industries plant

## Maire Tecnimont has developed its proprietary technology in the most efficient and advanced plastic mechanical recycling plant in Europe, producing about 40 thousand tons of recycled polymers per year

In Circular Economy mechanical recycling offers high energy efficiency and great flexibility in the treatment of various types of plastic waste. NextChem aims to combine the different types of plastic waste and to improve its technical characteristics, thanks to its know-how developed to regenerate the recycled polymer. In February 2019 Maire Tecnimont entered this sector, thanks to the development of its proprietary technology in the most efficient and advanced plastic mechanical recycling plant in Europe, located at Bedizzole, in the province of Brescia (Lombardy region, Italy). The plant is

# The mechanical recycling of plastic

In 2016 plastic output (long produced from hydrocarbons) reached 300 million tons worldwide and 60 million tons in Europe alone. Of these, only about 5% is channeled to recycled production with a significant share of plastic waste dispersed in the environment or sent to incineration or landfills (due to the lack of recycling plants). The energy transition underway is focusing the main players in the sector, both producers and buyers of plastics, on more sustainable production approaches which provide for more virtuous and effective recycling methods according to the principles of Circular Economy.
Mechanical recycling is, to date, the most widespread process to channel the plastic waste towards reuse in the consumer sector. The number plants in Italy still does not match the urban and industrial waste recovery output.



*Details of the MyReplast industries plant*

managed by a new company, **MyReplast Industries**, a subsidiary of NextChem, and local businessmen as minority shareholders. In view of a new sustainable economy of plastics, this is an important step in Maire Tecnimont's Green Acceleration strategy. The application of the group's process and plant-building skills to the new mechanical recycling business offers interesting opportunities in a sector that needs to industrialize the regeneration cycle of plastic materials.
The MyReplast Industries plant has the following key characteristics:

- **Significant output**: the plant is currently among the largest in Europe and is able to produce about 40 thousand tons of recycled polymers per year.
- **High flexibility**: the complex is able to treat various types of incoming plastic waste, both from industrial production (for example, components of cars, food and industrial packaging waste), and from post-consumption, that is urban sorted waste.
- **Quality of finished product**: The MyReplast Industries plant - based on an economically sustainable business model, without the use of public incentives – produces high quality recycled polymers, with recycling efficiency of around 95%. This is an essential feature to approach high value-added "premium" markets and bridge the qualitative gap between recycled plastic and virgin plastic (coming directly from fossil hydrocarbons).

Thanks to Maire Tecnimont's leadership in the construction of hydrocarbon polymer production plants, the Group can play an accelerating role in the Circular Economy. In fact, reuse and recycling of polymers will create new raw materials and avoid their dispersion in the environment. In this field Italy can aspire to lead the transition towards green chemistry thanks to its great tradition of research, technology and industry.

*Regenerated polymers. On the background, an example of finished product*

## Carlo Nicolais

Carlo Nicolais is the Head of Institutional Relations and Communications, Maire Tecnimont Group.
Born in 1973, he graduated cum laude in Political Sciences from Rome 'La Sapienza' University in 1999 and earned in 2004 a PhD in Development Economics and Politics from University of Naples.
He has matured experiences at different universities, companies and social organizations in international relations and development cooperation. From 2010 to 2012 he has been communications manager of Federprogetti, the Italian Federation of Industrial Plant Engineering companies.
He joined Maire Tecnimont Group in 2006 working in corporate communication. Since January 2010 he has been appointed Head of Public Affairs of the Group. He holds his current position since November 2012.

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# Micro LNG plants on transportable skids: the new biomethane route

The SIAD Group designs and builds micro biomethane upgrading and liquefaction plants for the production of LNG, for local usage, for fuel for service stations or for micro distribution industrial combustion and heating grids

**Pierluigi Gritti**, Air Separation Unit Division Director, SIAD Macchine Impianti
**Marco Possenelli,** LNG Business Development Manager **,** SIAD
**Maurizio Bellandi,** Biogas Upgrading Plants Sales Manager, Tecno Project Industriale

From 2 March 2018 the national agricultural sector can benefit from the incentives devised for the promotion of the use of biomethane and other advanced biofuels in the transport sector. The SIAD Group, with SIAD Macchine Impianti and Tecno Project Industriale, develops innovative leasing projects which help Italian companies enter this sustainable and promising market.

The SMART LIN-LNG biomethane liquefaction plants are available on loan and can transform the costs and related purchase charges into a simple rental agreement. Even the smallest farms that generate biomethane from biogas are thus encouraged to invest in an economic opportunity for risk-free profit and an almost immediate return on their investment.

SMART LNG plants are the first and only system solution proposed in Italy for the liquefaction of natural gas (LNG) on a small and medium scale.

The main phases of the process are:

- Pre-treatment for the removal of contaminants from natural gas, such as: water, hydrogen sulphide, heavy hydrocarbons, carbon dioxide and ammonia;
- Liquefaction, achieved by: a heat exchanger, which exploits the refrigeration units provided by the evaporation of liquid nitrogen and its subsequent overheating up to room temperature, or a heat exchanger integrated in a liquefaction cycle that recycles nitrogen including compressors and turbines.

*Micro-liquefaction plant with a capacity of 130 kg/h*

By the end of 2019, the SIAD group will have supplied a major agricultural company, the first to enter the biofuel market since the decree came into force, with a SMART LIN-LNG liquefactor which obtains natural gas from livestock waste and the organic fraction of municipal solid waste (OFMSW).

The plant will use the process of the evaporation of the liquid nitrogen made available to the plant by tanker. The project is completely tailor-made and has a modular structure that is complex and detailed from an engineering point of view, which will be able to produce up to 3.2 tons of liquid biomethane per day.

Biomethane from the liquefaction process will be used as an environmentally friendly alternative biofuel by the transport and haulage sectors. The plant has been pre-assembled in the factory on a single skid: the installation will require only a few

| "SMART LNG" system range | LNG production | | |
|---|---|---|---|
| | Nm³/h | TPD | kg/h |
| SMART LIN-LNG | up to 1 400 | up to 25 | up to 1 040 |
| SMART TB-LNG | up to 33 600 | up to 600 | up to 25 000 |
| SMART INT-LNG | up to 33 600 + LIN | up to 600 + LIN | up to 25 000 + LIN |

connections to the liquid nitrogen container and the LNG container. It is hoped that this project will inspire other farms or activities that currently use the biogas they produce for electricity generation thanks to particularly advantageous rates. At the end of the electrical incentive, the biogas will be used for the production of biomethane and, at the same time, for the purification of $CO_2$: the membrane skids of the upgrading plant are designed for the necessary integration to obtain maximum efficiency in all phases of the contract and its possible developments.

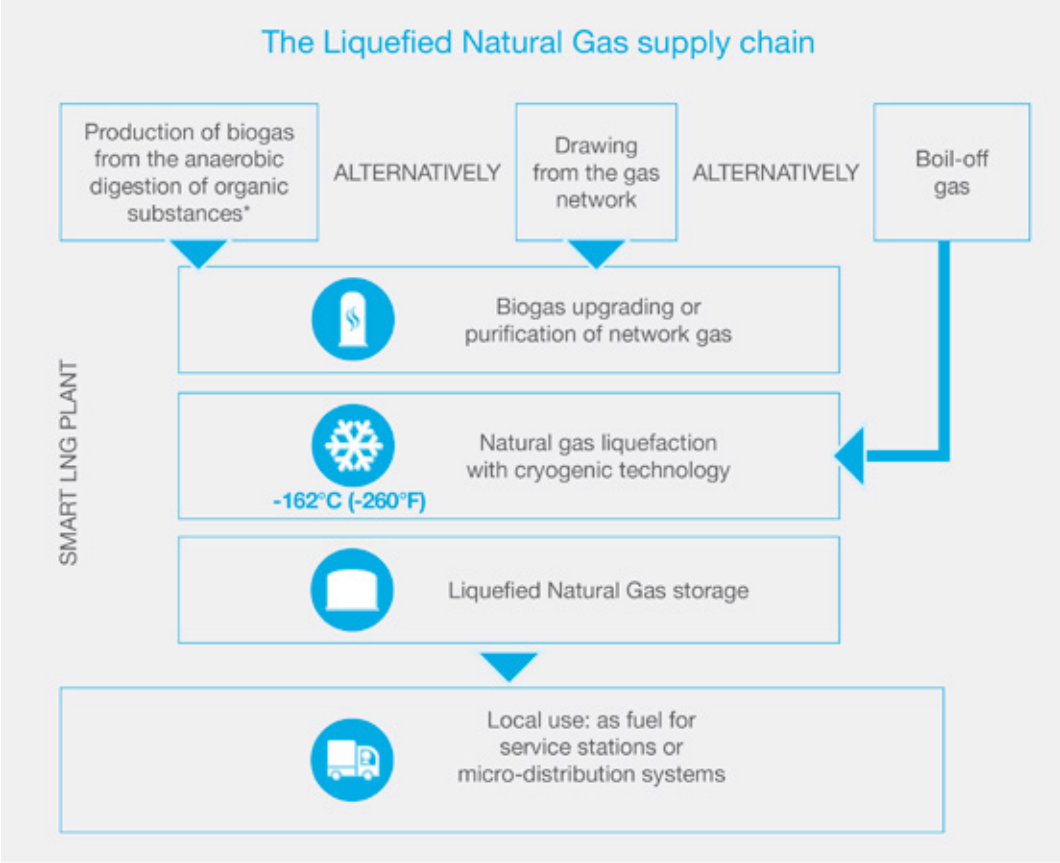
## The SMART LIN-LNG biomethane liquefactor

The new plant is suitable for liquefying 130 kg/h (180 Nm³/h) of biomethane from the biogas upgrading plant at a pressure of 16 bar. The molar composition of the biomethane to be liquefied is as follows:

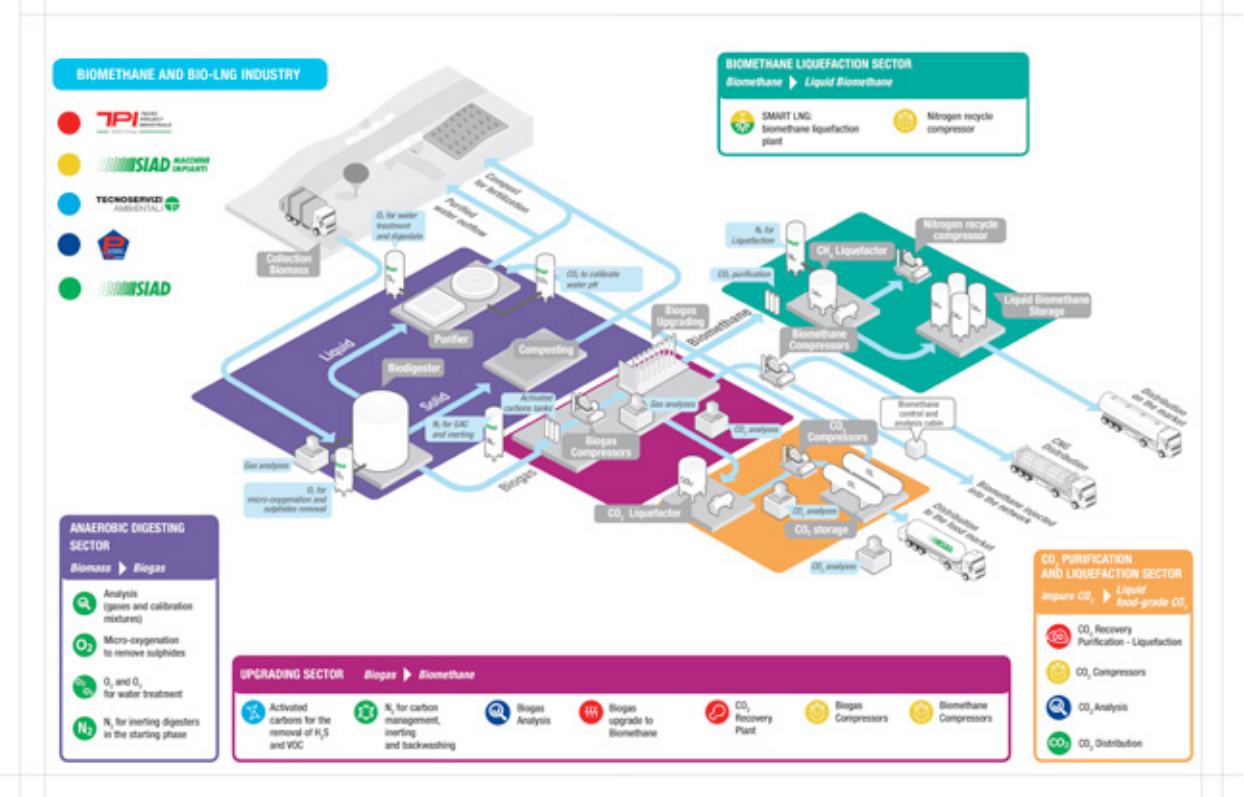
- methane 98.5 %
- oxygen 0.3 %
- carbon dioxide 0.5 %
- nitrogen 0.7 %

**Smart LNG highlights four key aspects of SIAD Macchine Impianti's engineering skills:**

- **robust and consolidated cryogenic technology;**
- **a flexible liquefaction process;**
- **operational safety;**
- **maximum environmental sustainability.**



## The biomethane supply chain through the solutions of the SIAD Group




## SIAD

The parent company, SIAD, supplies proprietary gases, technologies and services for all stages of the biomethane production chain, from microoxygenation with oxygen to nitrogen for methane liquefaction and inertisation, from oxygen for wastewater treatment to certified mixtures for calibrating analysis tools.
Analysis and characterisation of biogas for the designing of the upgrading plant is part of our expertise as well.

## Tecnoservizi Ambientali

In partnership with the world's leading supplier of activated carbons, Tecnoservizi Ambientali offers a targeted service for the purification of biogas from different sources. Its services include the supply and handling of active carbon and the reactivation of spent active carbon. Furthermore, Tecnoservizi Ambientali deals with the recovery and disposal of critical raw material from industrial waste.

## Tecno Project Industriale (TPI)

Specialized in the production of gas purification/refining plants, TPI has developed a proprietary biogas upgrading solution to produce biomethane from agricultural sources, the organic components of municipal solid waste, sewage sludge, processing waste and other biomass. Tecno Project Industriale is able to recover biomethane with more than 99% purity and food-grade carbon dioxide for other uses.

## SIAD Macchine Impianti (SIAD MI)

An undisputed leader in the cryogenic liquefaction of technical gases at national and international levels, SIAD Macchine Impianti has developed the SMART LNG series, a new and innovative type of plant for treating and liquefying methane on a small-to-medium scale using nitrogen as a refrigerant.
The company also offers a range of compressors for managing all gas flows in the upgrading and liquefaction process, including biogas, biomethane, carbon dioxide and nitrogen.
For LNG regasification terminals and coastal storage depots, SIAD MI has developed a specific range of compressors for treating boil-off gas. SIAD MI also uniquely provides a Global Service throughout its entire production chain.

## Pentatec

Pentatec is the gas analysis division of the SIAD Group in the biomethane production chain, offering advanced solutions for the analysis and quality certification of gases generated by biogas upgrading plants.

Before being liquefied, the biomethane undergoes a purification treatment to completely eliminate carbon dioxide, down to a residue of 30 ppm.

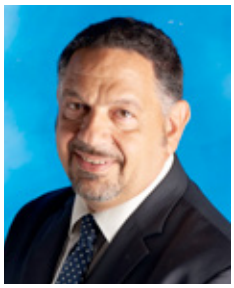
Producing biomethane from biomass and organic waste is an initiative that perfectly combines the reduction of environmental impact with the generation of clean, self-produced and renewable energy.
The same initiative, together with the incentives promoted by the State and supported by the SIAD Group, also through the use of equipment on loan, has turned into an important economic advantage for all companies wishing to invest in advanced sustainability.
In the longer term, the design of plants that can be transported by truck or trailer has already been planned, in order to facilitate movement of the same plant for use at different sites. As part of a 100% sustainable biogas valorisation process, the SIAD Group integrates a complete range of specific processes and products for each phase of the LNG production chain into the design and construction of its plants.

## Pierluigi Gritti

Pierluigi Gritti graduated in Mechanical Engineering with an energy specialization from the Politecnico di Milano. Prior to his current position he was the Technical Director dealing with both the design of oxygen, nitrogen and argon production plants and the design of alternative compressors.
He has gained considerable experience in cryogenic plant applications; he has been a member of the European technical committee CEN / TC 268 “Cryogenic Vessels”; he is currently a member of the UNI / CT Commission 037 “Containers for the transport of compressed, dissolved or liquefied gas” and Coordinator of the Working Group UNI / CT 037 / GL 01 “Cryogenic Vessels”.
He has collaborated in obtaining a patent for the liquefaction of nitrogen using the recovery of refrigeration deriving from the evaporation of liquid natural gas.

## Marco Possenelli

Marco Possenelli graduated in Geological Sciences at the University of Trieste. He has worked with several companies in the field of geophysical research and analysis, holding the position of site manager in Italy and abroad. From 1998 in SIAD he carries out commercial activities in the industrial gases sector and in the development of special applications. He is currently a Business Developer in the Environmental, Energy and LNG sector with a particular focus on developing partnerships and market analysis.



## Maurizio Bellandi

Maurizio Bellandi, is currently in charge of Biogas Upgrading Plants for Biomethane production and $CO_2$ purification and liquefaction plants.
He began his career in the world of urban solid waste collection and treatment and Forsu in the early 1990s; in early 2000s he started to work in the plant engineering world, collaborating with companies specializing in the production of cogeneration and biomass gasification plants, anaerobic digestion with agricultural matrix and Forsu.

# IMI Remosa: worldwide achievements in valve critical applications

Two examples of critical challenges, one in UAE and the other in Australia, managed with a problem solving approach in partnership with IMI sister companies

**Giulia Piombi**, Marketing Manager, IMI Petrochemicals

IMI REMOSA is a world leading engineering company, specialized in designing and manufacturing of valves and actuating systems for critical applications in petrochemical industries, thanks to its high-level Lean Management, Lean Engineering and Lean Manufacturing, with dedicated commitment to the Research & Development of new solutions for Severe Service applications.

IMI REMOSA is confirmed every year as a leader among the providers recommended by the main Licensors and Process Engineering Companies.

IMI REMOSA acquisition by IMI PLC has favored the growth of the Company in the Oil & Gas and PowerGen industries, with the creation of new products arising from synergies with IMI sister companies. The result of this partnership has led to the development of automation solutions and hydraulic power and control systems for units such as Catofin and Delayed Coking, maximizing the efficiency of the systems in compliance with the environmental policies.

Primary concern for IMI REMOSA is to satisfy the customer and, in same cases, hitting the target required efforts and customized solutions.

## The Challenge: 86" Triple Eccentric Butterfly Valve - never such a large dimension for the turbo expander inlet

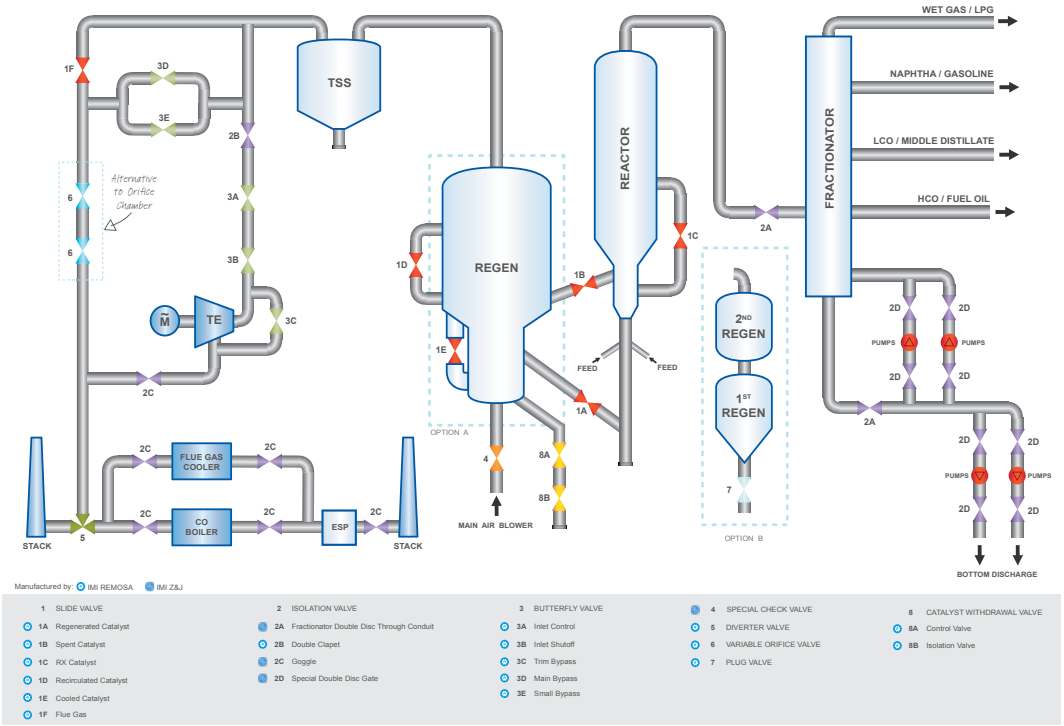
The largest oil refinery in the UAE, initially commissioned in 1981, underwent several expansions over the years. Recently, the Residue Fluid Catalytic Cracker (RFCC) was commissioned. It was one of the key expansion projects (investment volume of about $10 billion) doubling the refinery output.

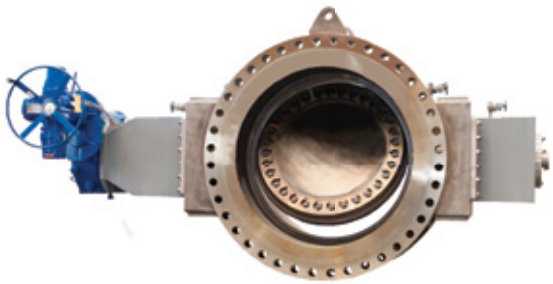

But an inconvenience occurred at the recently expanded area affecting different units, and IMI REMOSA was asked by the refinery operator to support with a trouble shooting analysis for a potential source of hazard coming from the butterfly valves at the expander inlet.

The standard FCC process flow layout and specifications envisage two butterfly valves in that position, i.e. 3A Inlet Control and 3B Inlet Shutoff, see the below process flow chart.

Standard design of the butterfly valves allows for a certain amount of gas leakage. But despite the two butterfly valves being in closed position, due to the large dimension (86") of the valves, the leakage of the expander was very high, and the expander turbine rotation could not be stopped. In this condition it was not possible to perform maintenance activities in a safe way creating a potential source of hazard.

**TYPICAL FCC & PRT PROCESS LAYOUT**



## The solution: IMI REMOSA promptly responded to customer's needs with the development of a new product resulting from the combination of know-how and experience of IMI Orton and IMI REMOSA

The IMI REMOSA expertise in FCC Valve technology shared with IMI Orton knowledge in triple eccentric design valves, permitted the right mix to solve the customer's problem. IMI REMOSA was able to offer a new 86" triple eccentric butterfly valve with significantly reduced leakage for proper isolation of the turbo expander. It was the first time that a triple eccentric butterfly valve was ever used in that process position. It was also the first time that such a large triple eccentric butterfly valve was ever produced.

IMI REMOSA had to study and select the right materials and the right valve design for a butterfly valve to cope with such extremely high temperatures, i.e. about 700° and a pressure of about 2 bar.
As an additional challenge IMI REMOSA was asked to deliver the prototype valve in less than six months. Thanks to the combined efforts of IMI REMOSA team in collaboration with IMI Orton, the project stayed on track with early delivery met in three months and a half (watch the video on IMI LinkedIn https://www.linkedin.com/company/imi-critical-engineering/ )

## The Challenge – IMI REMOSA solves the problem of an Australian Refinery

IMI REMOSA was awarded the order for three new angle valves to be installed in the Fluid Catalytic Cracker (FCC) unit at a refinery in Australia, operated by a major Oil Company.

Angle valves are designed for throttling or isolating flow in commercial and industrial applications. The particular shape gives the advantage of allowing it to function as both a valve and a piping elbow, with consequent

space and material saving. In this specific case, the customer used these valves at the inlet, outlet and bypass lines of the filtration system upstream their Wet Gas Compressor. Due to relatively frequent maintenance required on this system, the valves need to provide sufficient leakage tightness to allow safe isolation of the equipment. However due to high erosion in the disc and seat area, the existing valves were not working in a satisfactory manner. Moreover, due to erosion on the internal bolting, it was not possible to disassemble the seat to easily carry out maintenance on the valves themselves, leading to increasingly higher leakage.

## The Solution – IMI REMOSA state of the art design for Angle Valves

For several years there has been a great business relationship with this major customer, and a respect for IMI REMOSA's technical know-how and outstanding manufacturing capabilities. As a matter of fact in recent years IMI REMOSA has been replacing competitor's slide and variable orifice valves, as well as refurbishing their plug valves at this Australian refinery. In light of this, the customer contacted IMI REMOSA to provide its expertise in helping to solve the leakage issue.
IMI Remosa proposed its state of the art design for Angle Valves, which features a domed disc and tapered seat to ensure a better sealing surface, the curved inlet cone section and extended application of special lining to limit erosion, and internal bolting design shielded from the flow to allow easy maintenance of the removable seat.

The solution proposed by IMI REMOSA's solved the customer problem and reinforced the long-lasting reputation of IMI REMOSA as world leading supplier of solutions for Fluid Catalytic Cracking critical applications… including DOWN UNDER!


## Giulia Piombi

Giulia Piombi, Marketing Manager, IMI Petrochemicals, has been working in IMI since 2015. She is a lawyer by background and she moved to the Sales & Marketing department last year, to face new challenges.

# Details Make the Difference

Taking dampers/diverters for granted can lead to major mistakes, resulting in unexpected and costly production stoppages

**Alessandro Borgonovo,** Senior Proposal Engineer
**Giovani Barbieri,** Aeroto Division Manager, Boldrocchi

Dampers may seem like simple pieces of equipment, but when they won't open or close, or when they're not tight, plant operators soon realize how important they are. Dampers/diverters are, in fact, often taken for granted – which has led some to make major mistakes in contracting inexperienced companies to produce their dampers, often resulting in unexpected and costly production stoppages.

**Dampers may seem like simple pieces of equipment, but when they won't open or close, or when they're not tight, plant operators soon realize how important they are**

Cepsa, one of Spain's leading energy companies, opted for a state-of-the-art diverter solution when it had to replace two multi-louvre dampers at its La Rabida refinery in Huelva, Spain. This refinery, with an installed capacity of 100,000 barrels per day, produces gasoline, butane, propane, gasoil and asphalt. Cepsa was very pleased with the diverter damper Boldrocchi supplied in 2010 downstream of a GE Fr. 7EA gas turbine and Boldrocchi was chosen once again to provide a top-quality diverter solution for these outdated dampers manufactured by another company. The contract, however, not only sought a well-engineered solution, but one that used the existing structures and by-pass stack, minimizing modification costs. This retrofit required considerable consideration as available space to fit the new solution was very tight. Installation was also to be quick to minimize the gas turbine shutdown period. This affected the manufacturing plan.

Boldrocchi was up to the challenge. Headquartered near Milan, Italy, Boldrocchi Group is a world-renowned engineering, manufacturing and service firm dating back to 1909, now with products in over 140 countries. It offers a wide portfolio of integrated solutions to the heavy industry and power generation sectors and supplies all major EPCs and end-users with heavy-duty dampers and diverters, fans, blowers & compressors, environmental solutions, heat exchangers & coolers, and gas turbine systems & noise protection.


Boldrocchi also has significant experience in revamping/refurbishing/retrofitting existing systems. Indeed, reusing existing parts (in this case, the structure), reduces CAPEX while not only improving performance, but capacity as well (if necessary). In this contract, the customer chose to replace the two existing multi-louvre dampers with a single-blade diverter, as it would offer the following advantages:

- A higher degree of tightness: an essential requirement to be able to carry-out maintenance on the boiler in absolute safety, even when the gas turbine was running.
- A guarantee that the two outlets, towards the by-pass chimney and towards the boiler, were never simultaneously closed: one blade and a single actuator would ensure this.

Different challenges arise when new diverter dampers are to be installed using existing structures – especially when the structures were designed for a different model of diverter damper: there are limited flange-to-flange dimensions that must be respected and strict tolerances, different insulation solutions at the battery limits, and constraints on both the diverter support solution and the fixation points chosen.

Boldrocchi custom-makes every diverter damper for every client: this was no exception. A detailed site survey was performed before the start of the engineering activities to check all dimensions and the condition of part of the plant in question. The site survey did confirm that the existing structure was in good enough condition to be reused.
The engineering team did precise mechanical studies using 3D modelling in order to ensure the new diverter damper fit perfectly into the very tight existing space. This 3D modelling also guaranteed the interfaces were precisely positioned. This is another important step as any slight deviation could have an unpredictable impact and the accuracy of the engineering is essential to avoid any problems. When designing the diverter damper, the team also paid special attention to the assembly plan with the goal of minimizing the length of erection activities in order to reduce the gas turbine shutdown period.

## Boldrocchi custom-makes every diverter damper for every client: this was no exception

The diverter was completely pre-assembled in Boldrocchi's 45,000 $m^2$ (500,000 $ft^2$) workshops in Biassono, Italy, ensuring quality steelworks and welding. The company also has the largest in-house test facilities in Europe and North America, meaning functional tests could also be performed at the Biassono facilities as well. This included testing the hydraulic actuation and the air sealing system. Critical parameter verifications, such as operation time (under 10 seconds for emergency closure), geometric sealing and air sealing pressure, were performed during factory acceptance tests (FAT) at the in-house facility in the presence of a Cepsa technician.

The diverter was shipped by truck from Italy to Spain in a mere two pieces: the idea was to have the fewest number of pieces to re-assemble on-site while still adhering to maximum transport sizes to avoid extra costs due to oversized loads.

On-site, the two pieces were re-assembled under the supervision of a Boldrocchi specialist in a dedicated area near the diverter's permanent structure and the actuation system and blade were installed. The diverter was cold-tested, then placed in the existing structure

as a single module with no issues. Finally, commissioning was done rapidly by specialized Boldrocchi personnel on December 18, 2018 and the gas turbine was restarted.

## *Conclusions*

Reusing existing parts when replacing a system such as this diverter damper is an ideal way for plant operators to save CAPEX (at times a considerable amount) while still boosting plant performance. Such a retrofit can often increase capacity while requiring minimal (or no) layout changes and also reduces plant downtime.

**As the diverter damper must be customized to fit in a very specific structure, it is the team's experience and know- how that guide them to analyze all details that could cause problems on site, details that make a difference**

It is crucial, however, to choose an experienced company that prioritizes precise engineering and manufacturing. As the diverter damper must be customized to fit in a very specific structure (that is not in the manufacturing facility, but rather far away, on site), it is the team's experience and know-how that guide them to analyze all details that could cause problems on site, details that make a difference.

Diverter dampers play a key role in plant operations, both in terms of performance and safety. Their efficacity should be primordial: precise, customized engineering and quality manufacturing is not where plant operators should skimp to save money. A better cost-effective measure is to evaluate whether existing parts can be reused and go the retrofit route.


## Alessandro Borgonovo

Alessandro Borgonovo – Senior Proposal Engineer
After bachelor's degree in mechanical engineering at the Politecnico di Milano, he joined Boldrocchi s.r.l. in 2004. He worked as Project Engineer and Project Manager in several projects for the supply of air intake and exhaust systems, always in contact with main OEM and EPC contractors in energy markets.
In the last five years, he has been working in the proposal team, making available his experience about technical and management aspects of contracts for complex projects, in order to support the Sales Department during the bid stage.



## Giovanni Barbieri

Giovanni Barbieri is the Director of Aeroto Division in Boldrocchi, the Business Unit in charge of Gas Turbine auxiliaries, Heavy Duty dampers and Noise Protection systems.
He has worked in Oil & Gas and Energy field for more than 20 years with worldwide experience.
Giovanni Barbieri holds a Master degree in Aerospace Engineering from the *Politecnico di Milano* and a post graduate Master in Business Administration.

# It is time to prevent infernos like the Deer Park or Crosby fires

Shifting attention to preventing such prolific fire incidents from taking place in the future

**Sharé Mason-Bailly**, Business Development Manager
**Stefano Armani**, Engineering Manager
SA Fire Protection srl

In the wake of the recent fires in the Texas Area at the ITC petrochemical facility in Deer Park and the KMCO plant in Crosby (USA), there has been a lot of attention cast on preventing such prolific fire incidents from taking place in the future.

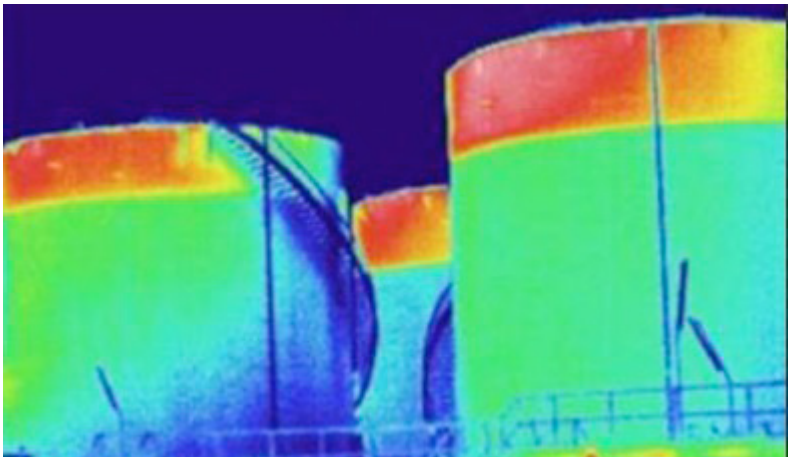
In addition to the risks of a potential domino effect (where the tanks in the surrounding area also can catch fire), there are several commercial and environmental risks that can quickly sprawl out of control due to the nature of the highly combustible liquids being stored.

It is not yet known the initial cause of the fires, which have caused millions of dollars-worth of damage to the facilities and the environment as well as having claimed life in the case of the Crosby facility. The incidents could be due to gross negligence or a naturally occurring phenomenon. Likewise, the incidents could have been due to something as simple as operators detecting a problem in the process, then deciding to close a valve to shut off the flow to the affected area which could put a flange (further downstream), under pressure causing the flange to leak. Such a leakage could lead to a fire scenario a few weeks, days or hours later if unchecked.

In such a scenario, heat and flame detectors would only notify operators once a fire starts, at which point action can be taken but no information as to the cause of the fire would be available until later investigation is performed.

Whether its piping, pumps, flanges, valves, turbines, compressors, electric cabinets, power supply cabinets or vehicles operating in the ATEX area, gas or hot liquid could escape/ leak from any of these areas which could later lead to a fire.

Normally, End Users want to detect a fire as soon as it starts; however, the focus should shift to detecting those events which could potentially lead to a fire condition. Such early detection should not substitute



heat/ flame/ gas detectors but instead should be added to onsite safety.

**Instead of concentrating on fire detection, the focus should shift to identifying events which could potentially lead to a fire**

An early detection and surveillance system should be capable to:

1. Detect a problem in the process in its infancy that could potentially lead to fire
2. Give operators an early warning using real time images so that preventative measures can be taken
3. Store images and time stamps in the lead up to the fire incident which can later be used for post-fire analysis

SA Fire Protection have developed an early warning system that is capable of achieving the above-mentioned points A, B & C. The system consists of a series of thermo cameras (for the safe or hazardous

area), coupled with a series of video cameras (for the safe or hazardous area), and all of the components in the server cabinet which are connected to a HMI/ work station.

## How does it work?

The system uses 2 interconnected cameras (one thermo camera and one video camera), focused on a target and connected to a CPU which is programmed using a specific software developed by SAFire. These interlinked images are in continuous comparison, self-checking and analysing the pixels of each image frame for abnormalities. Such a system can check the status of devices in the field, as well as being alerted to any variance which may impair the system in real time. By monitoring the critical flanges, pipes, valves etc. that are most likely to experience a leakage, the SAFire system allows operators to detect dangerous leakages early (BEFORE the ignition and subsequent fire).

For example, the end user can set temperature thresholds in the target area being monitored which can also take into account variants for typical changes in temperature which are normal to the process to avoid false alarms (there is also the possibility to set multiple targets of interest in the same frame). In such a way, operators can both detect and survey the extent of a gas leak or hot liquid leak as well as being able to detect possible scenarios of ignition so that preventative measures can be taken in advance. Thus, avoiding possible pools of hot gases or surges of hot liquid which could lead to fire.

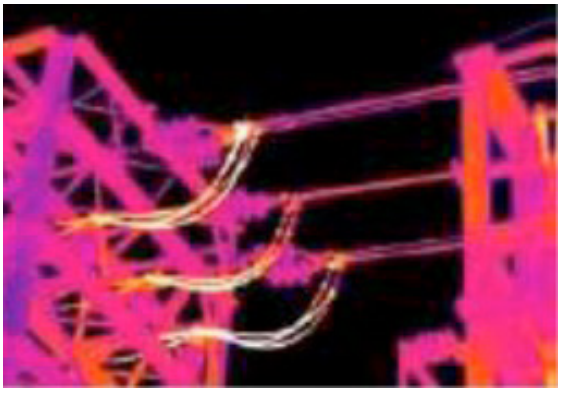
System statuses and alarms can be communicated to the control room or the Fire chief directly via the web. Operators can check and control the status of the system via the web (receiving system alerts and alarms by email, Modbus, SMS, Web etc.). This gives operators the ability to check the status of the target in real time (by way of the thermo and video cameras working in parallel), to detect leakage and survey the target.

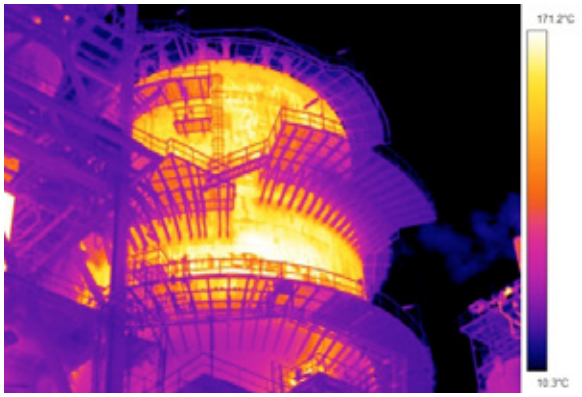
The images captured before and after an alarm event can be later used for offline analysis and root cause discovery (this post incident analysis can be used to check what happened to the flange etc. That information can be shared with HSE engineers to check what happened in the process before the event). This in turn increases the overall availability of the system which is fully customisable to meet End User requirements. The End User can also decide how long to store the images captured by the system's cameras.

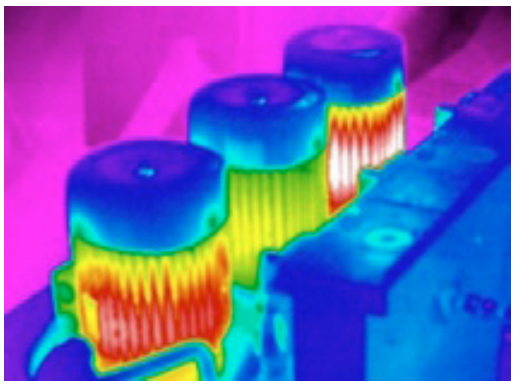
Traditional flame detection systems, as a standalone system, do not inform operators of the events which took place before the fire incident.

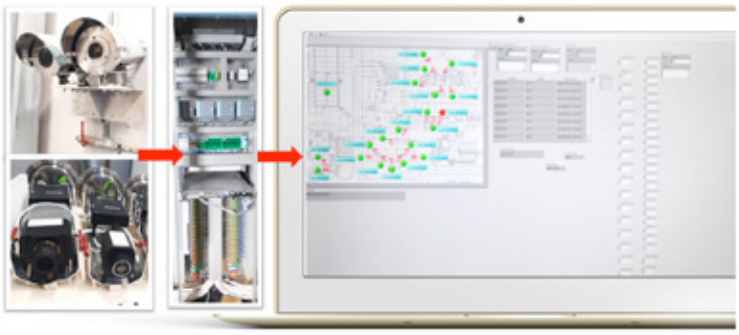
The SAFire Thermo Camera system can be used for numerous applications such as; Storage tanks; tunnels; server rooms; coal power plants; coal storage areas; loading areas; sulphur storage areas or waste treatment plants but to name a few.

**SAFire has developed a much improved Thermo Camera system that can identify the fire ignition zone before the fire event"**









## To summarise

There is a way to detect irregular changes in temperature and leaks before they have a chance to be ignited or lead to a dangerous blaze as seen recently in the USA. There is also a way to have a record of the cause of the fire for root cause analysis. The main differences between this Thermo Camera system and other heat, smoke or flame detection systems currently on the market are:

1. The current systems detect the event once a fire incident has taken place. On the contrary, the SAFire system is an early warning system that detects an abnormal situation (BEFORE A FIRE), that could lead to a fire which could be a week, a day or an hour before a fire could potentially break out.
2. Operators have the possibility to prevent a fire (TAKE PREVENTATIVE MEASURES), before it has chance to cause damage to property, assets or human life, thus increasing onsite safety.
3. The Thermo Camera system is a more cost-effective solution than other detection systems in the market due to simple architecture, standard components and significantly lower licence fees.
4. The system increases the reliability of the fire system due to the systems early detection (before a fire condition). Images and time stamps of the potential and actual fire can be stored.
5. Post fire incident analysis can be carried out easier and more accurately.

## Sharé Mason-Bailly

Sharé Mason-Bailly has been working with fire detection and suppression systems for the oil and gas sector for the last three years. Prior to that she spent six years working in the petrochemical industry where she gained a strong understanding of the industry especially regarding tank storage and downstream markets. Since joining SA Fire Protection Sharé has been involved in significant projects for Linde Engineering and Oiltanking Amsterdam. Sharé studied at Lycoming College (Pennsylvania), she holds a Bachelor's degree from the University of Westminster (London) and she also holds a Master's degree from Webster University (Missouri), which she attained at their international partnering school Regent's University (London), all of which have helped to further develop her business and technical skills.

## Stefano Armani

Stefano Armani has over 18 years of engineering experience. During that time he has developed strong expertise in automated systems and control systems for industrial applications. Stefano has been involved in every aspect of designing, manufacturing and testing of automated systems with special reference to having developed analysis equipment that is able to detect the amount of unburned coal in ash sediment with microwave technology. He has also developed a thermo camera system for waste management facilities to monitor the status of the combustion chamber up to 1700°C. within the last 5 years Stefano joined the SA Fire Protection Engineering department as the Engineering Manager responsible for project managing and system design for fire detection and suppression system on significant international projects such as Martin Linge in the North Sea, Umm Lulu in the UAE and the LNG Import Terminal Project in Bahrain.

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# The energy production industry anti-noise systems

Noise control and the reduction of sound emissions are primary goals in an energy production environment

In order to ensure that the production plant meets the requirements set by the law, it is of fundamental importance that all the systems have the necessary noise control measures in place.

Bosco Italia SpA manufactures systems for the reduction of sound levels and noise pollution. Thanks to almost 40 years of experience we are confidently in the position of offering the most suitable solution for any noise pollution problem.

Bosco Italia SpA designs, implements and installs a broad range of standard products as well as specifically dedicated noise control systems and turnkey fully comprehensive packages.

The equipment offered by Bosco Italia SpA meets all market needs, both in the case of highly technical contract specifications and in the case of particular requests by the customer.

Bosco Italia SpA offers fully comprehensive solutions for any gas and steam turbines sound-proofing or noise reduction needs, be it intake or exhaust silencers, cabins and shieldings.

All around the world, the number of steam and gas turbine power stations is increasing and Bosco Italia SpA can contribute by realizing safe and acoustically compliant packages.

Noise in power-generating sets is mainly caused by mechanical or magnetic ventilation systems.

For almost 40 years Bosco Italia SpA has been offering single and package solutions for noise reduction, by supplying sound-proof and sound-deadening cabins, exhaust and filtration systems, anti-noise containers and barriers.

Bosco Italia SpA designs and implements noise reduction systems for large coal, oil and gas boilers as well as biomass boilers and waste-to-energy plants, supplying soundproof and sound-deadening sheds and cabins, exhaust and filtration systems and antinoise barriers.

*Steam And Gas Turbines*

The hum generated by transformers is mainly due to the vibration of the core at the centre of the winding.

Bosco Italia SpA offers noise reduction single and package solutions by means of antinoise barriers, sound-proof and sound-deadening cabins.

Bosco Italia SpA studies and implements fully comprehensive noise control solutions for compressors, relying on the great experience accrued in almost 40 years of activity.

The company has carried out installations all over the world and is an acknowledged leader in the sector. The range of its products includes complete ventilation systems, sound-proof and sound-deadening cabins and sound reduction solutions for technical

Bosco Italia SpA designs and implements noise reduction systems for cogeneration plants.

Frequently the need arises of controlling noise emissions of exhaust and ventilation ducts from sound-proofed

*Power-Generating Sets*

buildings. Thanks to almost forty years of experience in the sector Bosco Italia SpA can offer absorbing, reactive and resonating silencers for air, steam and fumes.
Cabins are used for many purposes: weather and fire protection, turbine cooling, and to provide an effective sound barrier.
Thanks to its great experience, Bosco Italia offers the best possible sound-proof and sound-deadening cabins to achieve the acoustic criteria set in the project.
Our sound-proof cabins are used for:

- steam and gas turbines,
- power-generating sets,
- industrial boilers,
- transformers
- compressors,
- cogeneration plants.

Together with the product, Bosco Italia SpA designs and provides also effective ventilation systems to ensure constant internal temperature and pressure, for the good functioning of the machinery inside.
These systems consist of ducting and silencers with the aim of minimizing the noise coming from air flowing fast, usually employing biabsorbing baffles.
Bosco Italia SpA can offer the best solutions for air intake filtering in extreme conditions, like in the case of

*Industrial Boilers*

## Services

**Diagnostic analysis**
Performed by qualified acoustic technicians provided with high quality instruments and state-of-the-art laboratories for measurements and tests, to:

- acquire and analyze all sound and vibrational data;
- establish the scope of intervention through calculation models;
- carry out directly performance tests on products and equipment;
- provide all the technical documentation and certifications.

**Design**
Highly qualified engineers and invaluable know-how acquired in time and in all sectors of industrial and civil acoustics.
A modern engineering office to design, and to dimension all action on sound, structure and fluid dynamics:

- feasibility studies;
- cost analyses;
- innovative solutions;
- construction and workshop drawings;
- quality management;
- assistance and supervision during installation.

**Maintenance engineering**
Distribution of tools and instruments, services and consultancy for early-diagnosis of industrial plants, for predictive maintenance and the engineering of all energysaving maintenance.

Bosco Italia SpA is a distributor of:

- Instruments for the analysis of vibrations,
- Instruments for balancing and alignment,
- Instruments for the analysis of ultrasound,
- Instruments for thermographic analysis,

In its consultancy services Bosco Italia Spa also offers formation on predictive maintenance and maintenance engineering.

plants in deserts or arctic regions. The low quality of intake air could impair machinery operation, performance and life.
Also electrical, conditioning and fire systems are offered by Bosco Italia SpA.

The sound-proof cabins by Bosco Italia SpA deliver:

- Noise reduction between 10dB(A) and 40dB(A).
- Insulation from vibrations
- Noise controlled impact-resistant systems.
- Combustion air intake units (air filtering as an option)
- Light, ventilation, conditioning and fire systems, etc.
- Full installation service
- Modular solutions

Our modular sound-proof and sound-deadening cabins are built with our EKOKIT® panel system. By using this set of elements, partition walls, floors and ceilings of the highest acoustic standards can be built.
Among the advantages offered by the EKOKIT® panels are the quick laying and assembling and the fact that they can be disassembled. Thanks to the way in which the elements are joint together, if a cabin has to be stripped down and rebuilt elsewhere, it will not suffer any loss of acoustic performance, making them ideal for both permanent and temporary installations.
Bosco Italia SpA is a global market leader in noise control technologies as well as one of the main manufacturers of silencers. Silencers by Bosco Italia SpA meet all market needs, both in the case of high contract specifications and for particular customer needs.
Our team of highly qualified engineers relies on advanced selection software to optimize the most suitable solutions in terms of acoustic performance and budget.

*Transformers*

*Compressors*

**Production**
Performed at the modern San Mauro production unit of via Umbria 16, it comprises:

- manufacturing of all components (standard and special) to realize turnkey systems and installations:
  - Acoustic and dimensional testing of each component (quality standard);
  - Quality control of incoming materials and of finished products.

**Installation**
Assembling specialists and equipment to ensure the best installation of our components, to meet the highest quality and safety standards.

**MAIN CERTIFICATION**
-ISO 9001:2015;
-UNI EN ISO 3834-2 :2006
-EN 1090-1: 2009+A1: 2011
-SOA Categoria OS34, classe V – OG3 I° - OS 18-A I°
-Attestato Centro Trasformazione Acciaio
-White List
-Rating di Legalità

**ASSOCIATIONS**
-ASSOACUSTICA – Italian's Acoustics Association;
-ANIMP – National Contractors' Association
-ANIMA CIADI

**CONTACT**
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Email: noise@boscoitalia.it

Sales Manager:
Geom.Piero Calfa (Cell.335/6982264 –email: piero.calfa@boscoitalia.it)

*Cogeneration Plants*

*Sound-Proof And Sound-Deadening Cabins*

The experience accrued in almost 40 years enables us to provide solutions to meet any operational, mechanical and acoustic need.

## Applications of outlet and depressurization silencers

Bosco Italia SpA has accrued a great experience in the field of silencers for all sorts of process applications and sectors, among which are:

- steam and gas turbines,
- power generating sets,
- industrial boilers,
- compressors,
- cogeneration plants.

## Features of our silencers

Bosco Italia Spa offers a wide range of bespoke and standard silencers, conceived to reduce the noise coming from air, steam and gas outlets released in the atmosphere. All of our silencers have been studied and manufactured in accordance to the ASME norms and provide a noise attenuation in excess of 50 dB(A).

Our silencers are designed in accordance to international certified standards and deliver:

- High discharge rates.
- Fluid temperature between -200°C and +550°C.
- High upstream pressures.

In particular, our silencers can be:

- Designed to be connected to existing connection piping of any gauge and material.
- Flanged or prepared to be welded, according to the installation needs.
- Adequately welded for the features of the fluid, temperature and pressure conditions.
- Positioned horizontally or vertically.
- provided with stands, rain protection, grids etc. Performance meeting the specific application.

The silencers by Bosco Italia SpA come also in rectangular shape. Delivering a noise reduction between 30dB(A) and 50dB(A), with minimal pressure drop/maximum efficiency. They can be built in carbon steel, stainless and special steel.

# Imesa Intelligence for Saipem 7000

The company has been chosen for the revamping of the big crane ship, jewel of the fleet

The main features of the armoured internal arc switchboards designed by Imesa for Saipem 7000 are the extreme security and simplicity of use. Thanks to this innovative product, Imesa has won the Saipem contract for the renovation of the electric systems of the crane ship.

"This new project - says Sergio Schiavoni - is a further consolidation of the relationship with Saipem thanks to our ability to offer reliable, innovative and customised solutions. We are very proud to be working once again with Saipem".

For this project Imesa can capitalise on the upgrading works already performed on the Saipem fl eet, especially on the Castorone ship where the company has redesigned the generation, protection and control electric systems.

For Saipem 7000 Imesa will supply the main electric systems and the low and medium voltage switchboards. The division in subsections allows a more efficient energy supply and the possibility to isolate the area in the case of failure. The quality of the solutions is extremely high and thanks to the innovative design it is possible to have a better management of the space in the switchboard rooms.

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# SANCO the Italian "Fire-Eater" Expert Company

Significant success factors across projects dealing with fire safety

Presently SANCO is the largest Italian manufacturer in its field not only for dimensions and turnover, but it is also well known in the foreign market for the highest value it provides with experience, know-how, quality of products and flexibility toward the Clients, thanks also to its strong customer satisfaction policy.
In the latest years of its long history, SANCO has been investing its financial and human resources and, together with market research activities, it has been developing strong and efficacious marketing success, developing new technologies in its two different manufacturing lines:
- fire & gas detection systems
- fire suppression systems and fire vehicles

SANCO mainly operates in four core sectors: Power Generation, Oil & Gas and petrochemical complexes, steel industry and offshore platforms.
Recent countries of destination have been Kazakhstan, Russia, Gulf Countries and North Africa (80% of its total activity).
In numbers: 235 power plants, more than 150 projects in Oil & Gas petrochemical, dozens of offshore platforms and many steel complexes.
Leading policy is the goodwill to be present into major contractors vendors lists, obtaining products approval certificates by Internationally recognized bodies.
In order to satisfy Client's needs, SANCO applies at its best its knowledge, skills, tools, and techniques to meet project requirements, thus ensuring a project's long-term success.
Since the main manufacturing process is done in house Customers/End Users can visit our facilities and we have experience in case of changes at production stage (also just on time) for any possible implementation.


*Rail cranes at SANCO premises*

Manufacturing capabilities of electronical systems (fire & gas control panels) is of about 400-450 units per year, certified according to EN/CE, UL and EAC.
The latest result of this knowledge is the construction of the new control panel mod. INFINITY, the result of 3 years of R&D and of tests that have been giving birth to a high advanced product on the International market.
The mechanical shop owns tool machineries and

*Theoretical courses*

*Practical courses*

welding activities; gantry cranes of 40 tons capacity that can easily move big loading structures.

SANCO has also testing facilities for final tests and other tests such as hydraulic test and NDT (penetrant liquids, X rays…) welding visual test and magneto test. The only activities done outside are galvanization and painting processes.

Anyway, since market forces could force changes of scope or budget at almost any point during projects, project managers act as guardians of a project, understanding the need to be flexible throughout the project cycle, showing true leadership facing requested changing needs.

This is a particularity really appreciated by our Customers and, as a confirmation of this, 4 years ago SANCO awarded the Quality Prize by Lloyd's Register among 1500 Italian manufacturers.

It was the first Quality Prize for a Company in this sector. SANCO has also been certified according to ISO 9001, ISO 14001 and OHSAS 18001 QHSE standards by Lloyd's Register.

We have been selected for complete audit activities in order to examine in a deep way all departments involved in the quality process. SANCO has been successfully concluding audit assessment. Inspectors confirmed quality and Customers have been awarding Purchase orders with full satisfaction.

Projects have been augmenting and every project value reached, in some cases up to 12,5 million Euros (for a single job), meeting time schedules not incurring in any liquidated damage and complying with stringent specifications such as the ones required for projects in Australia, North Europe and Germany, North America and in particular South Korea and Japan.

Following the above process, we are proud to confirm that SANCO is presently important supplier of Scandinavian European Companies that have recently issued contracts, thus preferring SANCO rather than their regular suppliers.

This is a significant detail: environmental conditions for end users are really important, such as Kuwaiti petrochemical plants or Saudi Arabian refineries, where products with good performances are required to be functioning with temperatures up to 65°/80° C, or down to -52°C in Russia in general and Siberia in particular.

Experience and performance are key elements in order to obtain this type of contracts.

But the real questions when thinking about fire disasters is the following one: all fires can be extinguished?

The answer is quite simple but it needs to be explained in order not to reduce to bare bones a special and


*Fire Training Ground in Algeria*

*Fire Training Ground in Algeria (day test)*

*Fire Training Ground in Algeria (night test)*

challenging subject: all fires rise up from little sources that, through time, change and become even catastrophic.

Therefore, the elements to consider in order to extinguish fire in the best way are the following five steps:

**a) an adequate design activities**, made by a qualified and expert Company. SANCO for its engineering process holds about 40 qualified engineers, also having an experience of even 40 years in the fire fighting field and a team made of about 20 project managers working on the execution of projects, coordinating in-house and outside with suppliers and clients.

**b) a suitable construction and installation** of systems made in accordance with NFPA, through quality controlled processes, certified by International bodies

**c) identification and choice of a proper extinguishing agent** , that has to be apt for the type of risk to protect

**d) a professional training of operators** for a quick intervention: SANCO has already conceived and constructed training ground with real fires for testing performances of fire suppression equipment/systems and fire vehicles. SANCO has been also providing its own technical team for assistance to the construction activities of sites, providing always commissioning and starting up activities. Training courses are a noteworthy after sales assistance service in Italy and also abroad, on site. SANCO has recently provided this type of service for an important Italian EPC asking for training fire ground in Algeria where actual fire test are carried out in order to give functionality to fire operators for extinguishing fires.

**e) a rapid intervention on fire**. A reliable partner can be really helpful for this purpose. In fact, SANCO has also an "emergency service" (365 days H 24) for supplying products (available in house) in case of emergency.
Some years ago a large capacity monitor has been quickly shipped to Libya for extinguishing large fires of oil storage tanks, while another special mobile unit for emergency has been sent in Japan (by air).


*Emergency Shipping by air*

*High performances of special vehicle (130 mt throw)*

To sum up, **reliability, experience and availability** in case of emergency are fundamental needed features.

SANCO has been always following the changes in customer and partners values and behaviors fulfilling their expectations unconditionally, interacting with them throughout the life of the whole project, from inception to completion and beyond, providing a solid experience and professionalism driven by commitment.

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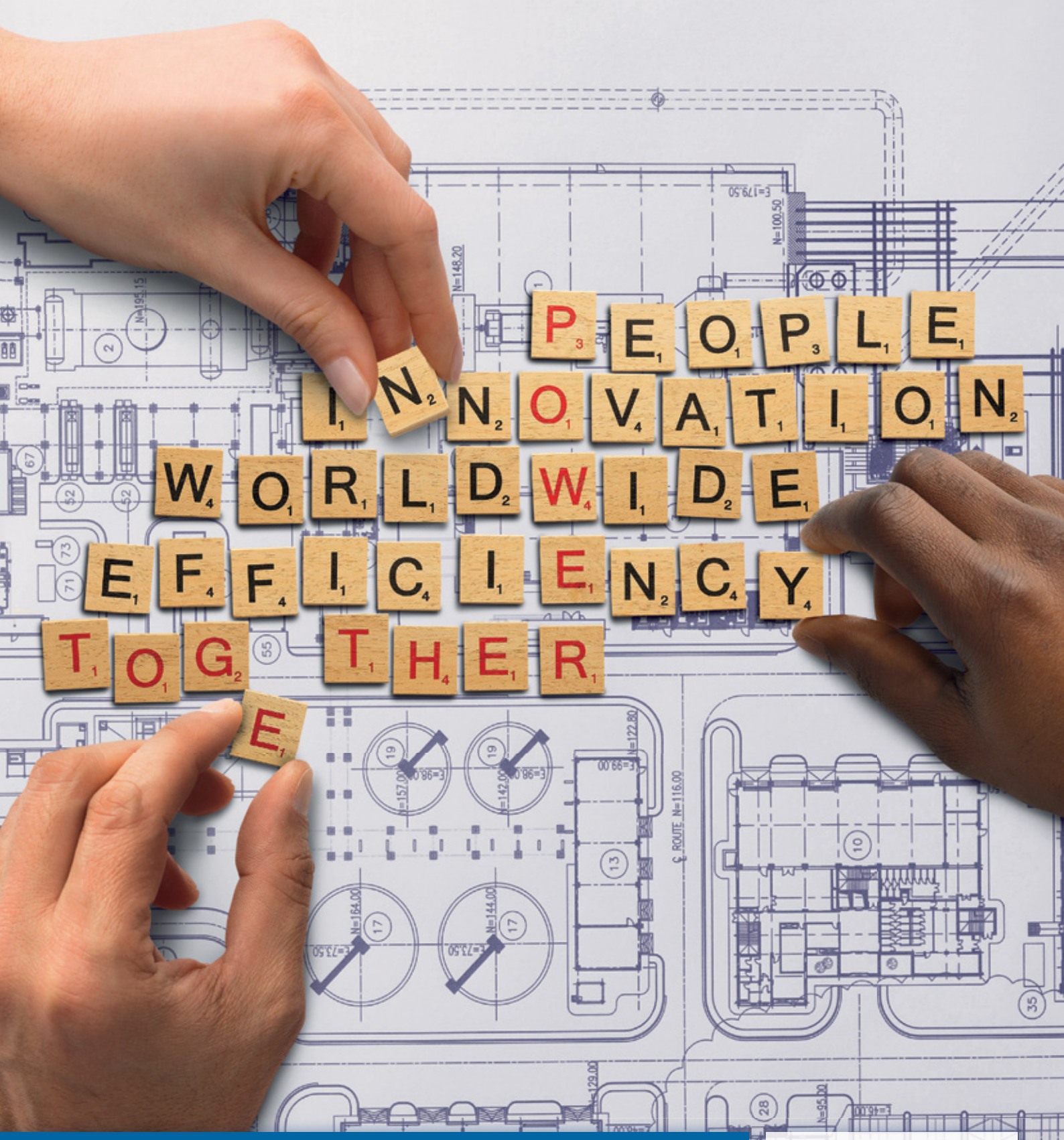


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In questa edizione 2019 offriremo sessioni parallele, che si svolgeranno nell'arco della giornata, dedicate a contenuti specifici per soddisfare appieno la vostra curiosità:

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