TRATOS Tt

CABLES FOR A MOVING WORLD

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About Us

Size

Values

Tratos Group

TRATOS CAVI S.p.a., the acronym of TRAfilerie TOScane, was founded in 1966 by Mr Egidio Capaccini, Engineer, in Pieve Santo Stefano in the province of Arezzo. The company, initially dedicated to drawing copper, then extended its working horizons by successfully starting the production of electrical cables and telecommunications cables.

In 1974 Albano Bragagni joins the company. By implementing a challenging set of investments, he initiates a process of technological growth and product diversification, entering new and qualified sector markets. Subsequently, with the establishment of new industrial and commercial companies, an integrated industrial group is created that is controlled by the holding company TRATOS S.r.l. run by the Bragagni Capaccini family comprising four members: Albano Bragagni, Marta Capaccini, Elisabetta and Ennio. Thanks to these technical-commercial upgrades carried out over the years, today this technologically advanced structure is at the forefront in the world of energy and telecommunications and operates in selected sectors with products of the highest quality.

Its continuous innovation process, the engineering expertise, the research on chemicals and materials, the highly qualified professional skills of its employees, its direct assumption of responsibilities, the teamwork, its focus on objectives and the decentralisation of local operational liabilities, are the basis of the competitive strength that consolidates Tratos in the processes of globalisation and of the development of special products "from cabling for transport networks to the fusion project for energy".

The company continues to set up operational offices around the world to maintain direct contact with its customers and is always at the forefront of the most significant projects with the aim of providing its support towards solving problems and of achieving top efficiency together.

The latest generation and advanced technology products combine well-proven and tested manufacturing techniques with an avant-garde perspective which give life to products with incredible resistance and flexibility thanks to new combinations of materials. By constantly collaborating with its customers, the company is able to produce cables according to needs and for any application through special projects which incorporate different components, thus managing to exceed all international standards and directives.
Tratos' main objective is to collaborate with the customer whose requests and needs must always be satisfied.
The company is always in a position to work with them by providing a dedicated expert-advice service, constantly available and reliable technical-scientific support and by designing the best solutions however complex the challenges may be.

Innovate change forever

From the factory door to the other side of the world

«The values that make an honest man or woman extraordinary are the same ones that make a good company exceptional».
"No one comes into the business world knowing everything.
Most of us know what is right and what is wrong.
The best companies are led by those who embrace continuous learning, identify best practices as they emerge, have strong values, and are committed to putting them into practice".

«Tratos' values already preceded today's pillars of corporate governance more than 50 years ago. These values are just as relevant today".

ENNIO BRAGAGNI CAPACCINI
VICE PRESIDENT OF TRATOS srl (Holding)

ELISABETTA BRAGAGNI CAPACCINI
CHIEF EXECUTIVE OFFICER OF TRATOS srl (Holding)

Innovation and development

Our story can be summed up in two words:
INNOVATION AND DEVELOPMENT.
Over the years, this drive has allowed us to always develop new products, even totally innovative and unknown to us, always in harmony with an innate and hidden desire for sustainability, among other things taking action in areas considered disadvantaged at least.
We were one of the very first companies in Italy to develop optical cables (production started in 1987), then telephone cables with solid insulation to replace paper insulated cables (1988), and that same year, the first supplies of nontoxic cables and cables that resist flame propagation.
We started the production of medium voltage cables in the early '90s and then all of our productions were adapted to the changing needs dictated by changing sensitivity and regulations.
In the early 2000s, we miniaturised cables to the point of inserting up to 288 fibres a diameter of 8 mm, which was an extraordinary innovation at the time and has become standard today. Around 2010, thanks to the fortuitous and fortunate meeting with E.N.E.A., we began the development of superconducting cables, which allowed us to carry out the European part of the ITER project with Criotec. This then gave us the ability and strength to design and build systems suitable for cabling any type of superconductor in the market today and used primarily by the C.E.R.N. in Geneva. Organising ourselves to produce conductors with voltage regulation without sacrificing extremely long cables has placed us with more prospects for quality and quantity in the world of mobile laying and off-shore cables, and at the same time we have developed an original in-house process for the production of high-voltage cables.

It has been possible to achieve everything described above, thanks to the collaboration, dedication, inventiveness and engineering skills of our staff, with **MASSIMO SERI** surpassing everyone.

Cables for a moving world

An exciting challenge that has allowed me to travel the world, open offices on 5 continents thus getting to know other cultures and new people. Each time I faced a different and interesting challenge. Even the mistakes I made along the way helped me grow and so the group has grown with me.

MAURIZIO BRAGAGNI
CEO OF TRATOS LTD

"We are fully dedicated to moving the world forward. We produce cables for a moving world and its dynamism distinguishes the company. Tratos cables move shipments, activate connectivity, transmit energy, allow transporting passengers and goods by rail and keep motorways flowing. Without sensible and intelligent innovation to keep the world moving, safely and efficiently, modern society would be structured very differently".

"However, it's incredibly important to us that we never lose sight of why we're here. Our business and our outlook are all built around creating change that delivers benefits. Whether it's increased efficiency, higher performance, improved safety properties, the growth of our people or ensuring we help those in need beyond our business, change defines our work and drives Tratos customers' businesses forward".

"We are constantly improving, innovating and developing new materials for cables, fibre optic products, PVC and fire resistant conductors. (Thanks to Tratos Firesafe for example, one of our most important patents for fire cables, we have created custom-made superconductors and developed reeling products which can work for decades). Research therefore, ranging from the latest fibre optic cable for super-fast broadband, to these high-speed reeling products currently operating in ports around the world. Our company's vision therefore, marked by study and innovation, plays and will play a fundamental role in setting the pace with the markets and above all with the most advanced technologies".

ALBANO BRAGAGNI
PRESIDENT OF TRATOS

Telecommunications and optical fibres

Telecommunications, and specifically the optical fibre cable industry, have represented since the early 80ies the very essence of innovation, which TRATOS has fully captured and transformed into its company mission.
With constant research investments in materials and construction design, TRATOS is an acknowledged leader in this industry, thanks to its product innovation capability and to the pioneering solutions that this company is able to provide. TRATOS can actually meet the requirements of the most demanding clients for the development of an optical fibre network, relying on an advanced engineering process that is suitable for an effective large scale production.
Numerous solutions developed by TRATOS in the last 20 years have become a reference for the cable industry, triggering technological advance and enhancing product performance levels for better final results, without losing sight of budget specifications aimed to network development.

The key factor for achieving these results at TRATOS is the company's ability to transfer experience across the different sectors of the cable industry, tackling real problems that wouldn't have been addressed otherwise.
Microcables with 288 fibres and a diameter of 8.0mm;
CPR-compliant microcables;
Telephone cables in copper-plated aluminium;
FTTH cables based on removable Minibreakout modules (single fibre) and Minibundles (multiple fibres);
FIG-8 self-supporting cables with removable Minibreakout modules (single fibre) and Minibundles (multiple fibres).
Over the time, a high level of cable engineering has allowed TRATOS to use all types of optical fibres available on the market, such as Multimobali 50/125 and 62,5/125, G652D, G657 A1 and A2, G653, G654E, G655, G656. Last but not least, TRATOS was the first European company to use fibres with a 200μm diameter to double the number of fibres inside their cables without changing the outer diameter. With this technique, end users can fit a greater number of fibres into the same cable size, thus increasing network potential.

Underwater cables

Since the early 90ies, TRATOS has been manufacturing components for medium and low voltage underwater cables, including those made of optical fibres. Over the years, the ability to produce these components and to perform the tests needed to use them in submarine OIL&GAS systems has stimulated TRATOS to invest in production, testing and handling machinery, in order to be able to manufacture complete cable products, and not just single components.
The first supplies of underwater optical fibre cables by TRATOS started in the mid-2000ies and they were used for the connection of the OFF-SHORE Adriatic LNG regasification facility on the Adriatic coast. Hence a number of associated projects, including power cables, ending with the production and commissioning of medium-voltage hybrid 18/30kV cables with 64 optical fibres, supplied to ENI SPA for the AREA 1 FULL-FIELD project in the Gulf of Mexico.
Regardless of the limitations connected with the factory logistics, TRATOS was able to find its own market share in the underwater cable industry, because the company can guarantee top quality standards and a highly-appreciated customer-oriented order management.
TRATOS can assist customers from cable design to engineering in compliance with international standards and meeting all system requirements. The company also caters for cable production, quality and acceptance testing, as well as the supply of installation accessories, supervision during cable installation and component commissioning. Customers are supported from the very early planning stages to system completion, providing on-site assistance, if necessary and requested.

MIRKO GORI
CEO TRATOS IBERICA
COMMERCIAL DIRECTOR TLC AND ENGINEERING

The ruins of a Tuscan village gave birth to a global business with a good heart.

Pieve Santo Stefano and its community, destroyed by the Second World War, were at the centre of a man's thoughts and desires... going back home from Argentina. This nostalgia and these thoughts ignited and fuelled his determination to put things back in their place, with the ambition to rebuild his home and achieve prosperity and security for his family and his fellow citizens.
Thanks to this great willpower, **Egidio Capaccini** is the one who created a **business** to help bring his homeland back to life. He built it to create work, housing and feed families, giving it a name that placed it at the centre of a saved community (**TRATOS** "TRAfilerie TOScane").

Capaccini was a good man who realised a vision with great values and a mission that has stood the test of time.
Correctness, respect and sharing are the fundamental principles that have remained in the company and Tratos... still has this vision, these values and the same mission.
Great gifts left by a man of honour and the highest levels of governance are still part of his important legacy today.

Tratos' Board launches the highest level of strategy and governance

The company's Board of Directors has fully aligned itself with the highest standards of industrial governance by fully adopting the Code of Conduct for public appointments. In order to improve the structures and the guiding strategies, already in 2021 executive and non-executive members must be in a position to work according to the highest personal and professional standards, following the directives of the Code itself.
The legislation clearly establishes the guidelines for the Boards of Directors of public bodies and these directives are an integral part of the terms and conditions for appointing members. In addition to defining expectations, the regulation also lists the parties to be excluded: intolerance, harassment, bullying or other discriminatory acts and therefore, any behaviour outside the Code, is considered a violation of the terms of appointment.

The Code also includes the provisions of existing disciplinary documents that refer to the responsibilities and obligations of board members, and by adopting it fully or even ahead of its time, Tratos paved the way for best business practices while always maintaining its policy and standards to the highest production and commercial levels. Based on this: conduct, quality, renewal and sustainability, the Tratos Group has been awarded the Queen's Award for Enterprise, the UK's main award for companies that excel in international trade, sustainable development, promotion of opportunities and in the innovation of advanced materials and technologies.

A history of passion, tradition and innovation

20th Century

1966

TRATOS IS FOUNDED

After leaving his hometown at the end of the Second World War, Egidio Capaccini goes to Argentina where he finds work in a cable factory. He learns the techniques, develops his skills and returns to Italy to found Tratos.

1979

COPPER CABLES FOR TELECOMMUNICATIONS AND INSTRUMENTATION

The Bragagni Capaccini family acquires total control of Tratos S.p.A. and Albano Bragagni becomes president; Tratos starts the production of copper cables for telecommunications and for instrumentation.

1980

ALBANO BRAGAGNI JOINS THE COMPANY

When Egidio Capaccini, founder of Tratos, died, Engineer Albano Bragagni joined the company.

1981

TRATOS LTD IN THE UNITED KINGDOM

This company was born in order to improve production, sales and distribution in Great Britain. (Chesterfield-East Midlands)

1983

TRAMET IS FOUNDED

The factory for thermoplastic and elastomeric compounds is born. The production of telephone and rubber cables begins.

1983

FIRE RETARDANT AND FIRE RESISTANT CABLES

As the range of fire resistant cables grows, the company becomes a major supplier to the energy, rail, mass transportation, motorway, oil, gas, petrochemical, mining and tunnel industries.

1987

FIBRE OPTIC CABLES

Tratos is a leader in the telecommunications market and in 1987 it began the production of fibre optic cables for sale and distribution on an international basis.

1988

CATANIA

Tratos Cavi S.p.A. acquires the Catania plant.

1990

PRODUCTION OF MEDIUM VOLTAGE CABLES

After having purposely opened the new factory in Sicily in Catania, the company begins to produce and sell Medium Voltage products.

21st Century

2000

START OF PRODUCTION OF UMBILICAL CABLES

In collaboration with MFX, TRATOS starts the production of umbilical cables for Oil and Gas applications. In the same year, the third generation of the family joins the company with Ennio Bragagni Capaccini "Vice President of Tratos".

2008

ACQUISITIONS AND NEW OFFICES

Tratos Ltd acquires North West Cable Ltd and Modular Wiring System in Merseyside in the UK. Tratos Iberica SL is born. New strategies are implemented and offices are opened in Spain, Germany and China. In the same year, Elisabetta Bragagni Capaccini joins the company.

2012

FUSION FOR ENERGY CONTRACT FOR ITER

Acquisition of the Fusion for Energy contract through the company ICAS (ENEA-TRATOS-CRIOTEC consortium) under the direction of the "Product development manager - High Technology Division" Massimo Seri.

2015

AWARD TO TRATOS

The quality and the company growth were recognised in the UK by being awarded the Knowsley Business and Regeneration Awards: for the creativity, hard work, organisation and development of Tratos Ltd.

2016

TRATOS STARTS THE PRODUCTION OF HIGH VOLTAGE CABLES

From this further project and for this latest production, a new family plant "TRATOS HV S.p.A." was established in Pieve Santo Stefano. First supplies of carbon fibre carrier cables and of high voltage underground cables.

2016

INVESTMENTS

Considerable economic increases are made for the plants located in Tuscany with the aim of extending the technical, production and commercial capacity and of meeting the increased demand for superconducting cables and mobile laying.

2017

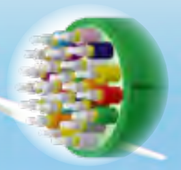
FIFTY YEARS

With the work completed at Knowsley, new, better performing machinery "both in terms of quality and production" became operational. The factory was enlarged by 400% and TRATOS Ltd is currently one of the UK's leading cable manufacturers.

2019

QUEEN 'S AWARD FOR INNOVATION

Tratos is awarded the **"Queen's Award for Enterprise"**: the UK's highest official recognition for the company which excels at international trade, innovation, sustainable development, promoting social opportunities and high-performance products.



2020-2022

MAJOR R&D PROJECTS (FRI)

Ministry of Economic Development

R&D project aimed at the design and development of innovative electric and optical fibre cables, with the use of multi-functional micro/nano materials and high-performance renewable materials (eco-compatible, bio-based and recyclable), in order to enable 5G and even 6G connection.

Bragagni Capaccini family

"Our founder "Egidio Capaccini my grandfather", has left a great legacy to this company, both in terms of structures and of managerial work. Our family has received so much to be proud of and to live up to whilst continuing his work. Every day we are committed to continuing this mission and my father, "Albano Bragagni", is the most obvious example. Everyone acknowledges his commitment and his passion for making the company grow while maintaining that spirit and those values".

«Despite the business, the members of the family still do not receive dividends and by investing the profits in research and innovation... the company grows, renovates, continues the work of my grandfather Egidio and with the same spirit and the same purpose. His Tratos aimed to rekindle hope to get out of that post-war desperation and to give people the opportunity to have a good job to recreate their lives... Good Lives, Good People. Even today, the family is careful to choose the locations where to build its factories... areas where jobs are most needed to provide support to those people and to the local economies».

ENNIO BRAGAGNI CAPACCINI
VICE PRESIDENT OF TRATOS

Tratos in the world

Founded in 1966 among the bonny Tuscan hills of Pieve Santo Stefano, **Trafilerie Toscane** later gave birth to the TRATOS Group and over the years, through acquisitions and mergers, to the Holding of the Bragagni-Capaccini family. A great deal of work and a lot of commitment towards research, innovation, sustainability, services and the professional education of its employees. Today, thanks to that great work, that constant commitment and the fundamental principles of the same family, the Tratos brand and its products can be found all over the world.

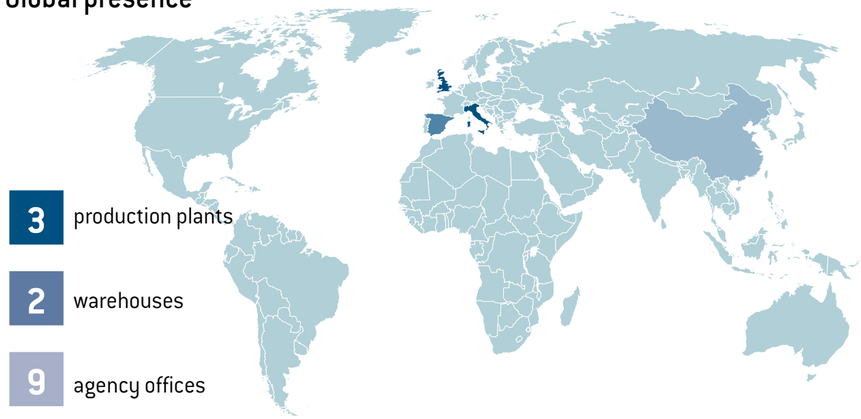
The group's production activities are carried out in four different plants and the close managerial links enable a full integration for technological development: from metallurgy to the production of specific compounds for cables, from stranding to insulation for low-medium-high voltage, from extrusion and vulcanisation for sheaths up to the final production process of telecommunication and fibre optic cables.

Tratos' representative offices and the direct connections in place globally are the strengths it uses to provide the best technical and commercial assistance and to carry out profitable market research which can satisfy the needs of current and future customers.
The group has made many and constant investments in research to satisfy the demand and the product market and sectors in general, but in particular for those with advanced technology and significant added value such as Medium Voltage cables up to 26/45 kV, High voltage up to 170 kV rating, for mobile laying, Offshore and with carbon fibre carriers.

A notable development has been achieved for optical fibre cables and Tratos has followed its entire historical path, from home distribution with micro-cables to covering long distances with special products (Optical Ground Wires).

Paying great attention to the future, the group is currently participating in development projects for nuclear fusion (International Thermonuclear Experimental Reactor and DTT) with specially designed cables made of superconducting filaments.

Global presence



3 production plants

2 warehouses

9 agency offices

TRATOS srl

PIEVE S. STEFANO (AR) - Italy - **Via Stadio, 2** - Headquarters of the Group's governance.

TRATOS CAVI spa

PIEVE S. STEFANO plant (AR) - Italy
Via Stadio, 2
It constitutes the initial nucleus in which the many types of Tratos cables were and are still manufactured and marketed either directly or with the help of the semi-finished products of the other production units.

CATANIA plant - Italy
Strada XIII-Zona Industriale
Semi-finished products, LV and MV cables with copper or aluminium conductors and XLPEHEPR insulation, LV and signalling cables are produced here.

TRATOS HV spa

PIEVE S. STEFANO PLANT (AR) - ITALY
Via Pian di Guido, 45
Starting from the copper or aluminium rod, the metallurgical process is carried out in its entirety (drawing - stranding – cable twisting).
We produce rubber compounds and blends for halogen-free cables, self-extinguishing, oil-resistant, flame-retardant and semi-conductive blends. Tratos HV has chain lines for Medium and High Voltage cables and for telecommunication with optical fibre or with metal conductor with solid insulation and foam skin.

Tratos (uk) Ltd

KNOWSLEY Plant (UK)
Randles Road
A wide range of low voltage cables are manufactured here, including those with interlocking flexible armour, available in both aluminium and galvanised steel and in sizes whose internal diameter ranges from 8.50mm to 33.50 mm.

Tratos China Shanghai Office

Headquarters in SHANGHAI (CHINA)
Xuhui District
Commercial representative offices.

Tratos cavi Iberica S.L.

Headquarters in MADRID (SP)
San Sebastian de los Reyes
Commercial representative offices.

Corporate policy is examined continuously and thoroughly in order to achieve the best general organisation and an excellent final quality of the products. Every management review is promptly transmitted to all operating structures.
Tratos adheres to a strategy of total commitment, constantly aimed at quality and this same strategy is always effective since it is not only applied within the company but also extended to its suppliers of materials and services.
As a demonstration and guarantee of this daily commitment, the company adheres to a wide range of international standards and these regulations are implemented in their entirety. Respect for these standards, established in accordance with the Sustainable Development Goals of the United Nations, allows Tratos to tangibly implement its own values that have always been carried out and which in some cases go beyond the indications of the certifying bodies. By supporting its stakeholders to maximise the benefits of international standardisation, Tratos is helping to achieve those United Nations Sustainable Development Goals and thus to ensure the adoption of the criteria of the International Organisation for Standardisation (ISO).
To protect employees and to protect the environment, the quality measures also extend to the production of halogen-free cables and moreover, Tratos has been using renewable energy from its own hydroelectric plant (Il Pozzale) since 1980 and in 2001 it began production of a cable for hydroelectric energy only. The group is always evolving and important plants are currently being implemented for the production of solar energy which will be used internally.

Certifications

TRATOS CAVI SPA
ISO 9001
ISO 45001
ISO 14001
ISO 14064
ISO 14067
ISCC+
Reg. 713/2013
ISO 50001
EMAS

TRATOS SRL (holding)
ISO 9001
ISO 14001
EMAS
ISO 45001
ISO 50001

TRATOS UK Ltd
ISO 9001
ISO 14001
ISO 45001

Certification bodies

Energy Certification

Lloyd's Register Group

Energy Efficiency Testing and Certification

Energy Efficiency Testing and Certification

Verband Der Elektrotechnik

Registro Italiano Navale

British Standards Institution

Istituto Marchio di Qualità

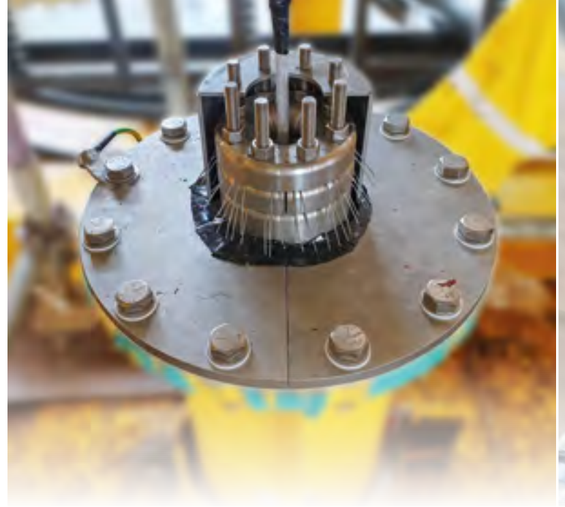
Loss Prevention Certification Board

Centro di Certificazione e Analisi comportamentale

GOST Russian Certificate of Conformity

Certificado de Registro de Empresa

Laboratoire Central des Industries Electriques



Key points for our quality management system

1. • *ESTABLISH*

tasks and responsibilities

2. • *MONITOR*

all processes

3. • *IMPROVE*

and maintain a high level of training of the personnel

4. • *ADJUST*

the system to market changes

5. • *RESPECT*

regulations

6. • *QUALITY*

is a corporate matter that concerns all operators

Since the initial Quality Control logic was adopted by manufacturers of electric and telephone cables, in 1987 TRATOS CAVI immediately obtained its ISO 9002 certification (BASEC - British Approvals Service for Cables) and ISO 9001 in 1993.

Everything can be improved; this is the principle that guides the Group when assessing its daily results.
The Quality system is rigorously applied to the entire production cycle according to scrupulous operating procedures inherent in the definition and dissemination of the standards to be applied. The operating activities and the related allocation of personnel tasks must always be in harmony with the management and with all company departments.

The substantial company investments, carried out over half a century, have produced and are producing great results, both in terms of product requirements and of per capita productivity.

CPR Construction Products Regulation

TRATOS - CPR

The CPR Regulation allows assessing the reaction to fires of construction products throughout the European Union, allows comparing different manufacturers from different countries, verifying how the product is introduced on the market, how its performance is declared and the conformity assessment system.
All TRATOS products subject to CPR are meticulously tested to meet the requirements of Class C or higher and most polymeric electrical cables fall into classes B2 to E. Based on the Construction Products and Fire Reaction Regulations, the Tratos®Waveform LSOH (Low Smoke Zero Halogen) multicore cable has obtained the B2ca-s1a,d0,a1 classification. The design of this concentric "neutral earth" conductor offers much simpler connections; de facto without cutting the cable, the sheath can be removed by virtue of the waveform model, with the result that the wires can be opened to allow the joint to connect to one of the internal power supply cores. Once the connection is complete, the integrity of the outer sheath can be restored with a T-cover for the joint itself. This **Tratos®Waveform** design allows DNO installers to pick up supplies without cutting the conductor cores. Tratos always exceeds the standards and has long since raised the bar of fire safety. For example, in the UK plant, it produced a new cable with higher specifications (CCA) than the standards themselves, thus soliciting the regulator to impose the minimum class (CCA cables reaction to fire performance). In the same factory (Knowsley-Merseyside-UK) the company carries out continuous research activities, implements constant innovation studies and engages in a rigorous regime of independent tests that are constantly in line with the quality of the products. The end Mission of the Group is the satisfaction of the customers and therefore... attention to the innovative system, to the concept of quality, and above all caring for the total well-being of its engineers and employees have accompanied Tratos in finding a solution for every situation. All this has enabled achieving those objectives, that mission and the satisfaction of the purchasing partners.

Fireproof and fire-resistant cables

In the United Kingdom and in Italy, the fire testing systems are latest generation ones and the various tests, which are always passed brilliantly and in line with international standards, allow a very high-level production to the satisfaction of the company but above all of our customers all over the world. As an innovation-oriented company, which works to develop customised conductors and towards seeking the best performance of the cables it manufactures, Tratos has considered it essential to invest in structures for the various safety tests, paying specific attention to the systems that manage the different firefighting tests (tests for voltage, spark, resistance, as well as more extensive tests for elongation, thermal shock, shrinkage and vertical flame).

Tests and measurements are always wide-ranging: they explore the time available to escape from fire (ASET), the area burning rate, backdraught, burning behaviour, char, combustion, deflagration, ease of ignition, fire load density, fire resistance, flame spread, mass and linear burn rates, smoke opacity, oxygen index performance and a great deal more. Tratos structures include a CPR test bench (BS EN 50399), small scale (Bunsen peak test) BS EN 60332-1, large scale vertical propagation BS EN IEC 60332-3, smoke density - 3 m3 BS EN 61034, NBS smoke density chamber, BS EN 60754 acid gas emission, test on gases developed during the combustion of materials, determination of halogen acid gas content, oxygen limit index (LOI) - ASTM D2863 and flammability index (FTI) - ISO 4589-3 (the details underlying the standards).

Vincenzo Bellini

The fire cables made by Tratos have been tested and certified by: LCPB, UKAS, BASEC, LUR and IMQ.

Icephobic Cables

The formation of snow and ice sleeves, which occurs in extreme weather conditions, on the conductors and the safety cables of high-voltage power lines can affect their mechanical resistance with a consequent disruption of the electrical system.

The patent concerns the application of a coating on the safety cables and conductors to mitigate snow and ice sleeves forming on the conductors and safety cables themselves.

The new cable concept developed by Tratos was designed taking into account both the functional features of the item and those of its actual industrial production.
Tratos has developed a cable capable of exploiting the principle of surface discontinuity combined with the icephobicity of the coating.

In detail, by exploiting the hydrophobic and icephobic properties of fluorinated polymers, we have created a cable with alternating metallic outer wires, one bare and one coated with polymer. This gives two effects: a surface discontinuity which favours the detachment of the snow sleeve and an anti-icing effect due to the presence of icephobic material on the surface of half of the elementary wires.

During an experiment in the winter of 2018-2019 it was found that the newly developed Tratos cable gives an earlier detachment of the ice sleeve compared to the sleeve that developed on the cable as is.

The results of this experimentation were published in IWAIS 2019 - Monitoring, measurements and mitigation for wet snow accretion on over-head conductor.

Patents in Europe

Tratos has 15 European patents, having studied and invested in various topics such as superconductivity and the development and production of aerial ropes with carbon fibre carriers.

Sustainability Best Practices

Plastic and cable industry need to move to a circular business model and to get there we are making an iterative strides forward. With a range of products made with different types of plastic waste Tratos extends its commitment to the circular economy and its value chain, while marketing innovative and more sustainable solutions. The benefits are numrous in terms of circular economy as it helps to cut CO2 emissions over using virgin material. There is a number of approach but the mass balance is the right one. The approach chosen to guarantee the traceability from the beggining of the supply chain all the way to finished product, replacing fossil feedstock with sustainability alternative feedstock. The control of the process is guaranteed by ISCC certification. From bio-based components a recycled compound was manufactured, saving fossil resources and cutting CO2 footprint.

Case Study

THE CHALLENGE

In 2021, Tratos received an invitation to join a tender, from one of the leading Italian based integrated operators in the global electricity and gas markets. In the tender, a higher technical score is awarded to cable solutions that are built with sustainable materials and/or through a more energy-efficient process. Ultimately, the solution should reduce carbon footprint when implemented. The leading integrated operator suggested that sustainable polyolefin sheathing compounds of vegetable origin for medium voltage (MV) and low voltage (LV) cables would be a viable solution.

THE SOLUTION

Borealis recognised that the outlined criteria could be met with the Bornewables™ solution. Bornewables is Borealis' portfolio of polyolefin products is manufactured with renewable feedstocks. According to the International Sustainability & Carbon Certification Plus (ISCC PLUS) classification, these premium polyolefins offer the same material performance as virgin polyolefins, but with a reduced CO2 footprint. Borealis produces Borstar® Bn ME6053, based on the Bornewables, a natural, UV stabilised, colourable, medium-density (MD) jacketing compound. With the help of Borealis, Tratos was the first of the tender invitees to offer a solution based on renewable feedstock. This key distinction set them apart from their competitors and helped them to win a considerable part of the bid.

THE RESULTS

Tratos is supplying cables to the leading integrated operator who is in turn providing energy across the globe with a reduced CO2 footprint thanks to the Borealis Bornewables™ solution. Along with it being the first cable presented with a jacketing made from renewable feedstock, it delivered a bigger CO2 footprint reduction per ton and with ICCS PLUS accreditation. With the Bornewables solution, for a 185 mm2 MV cable, Tratos reduced in 320 kg/km the CO2 emissions when compared to traditional solution based on fossil feedstock.

Current Projects

North West Electricity (ENW)

Shore power system
"Cold ironing"

Piccadilly – Extension
of the underground line

Power cables for
UK airports

DUSS Terminals
Germany

Overhead lines with
carbon fibre carrier

Submarine cable
for Eni Mexico

Mine cable in the
Baltic countries

Long Beach LBCT USA
Automated Terminal

High voltage cable
for ITER

Port PSA Voltri
Genoa – Italy

High speed broadband
in MDU

Peel Ports Liverpool 2
Container Terminal

High speed broadband
for Andorra

Research and development projects

In recent years, Tratos Cavi has undertaken an intense activity of Industrial Research and Experimental Development aimed at product innovation, in some cases radical (new product), in others incremental (product improvement). The aim is to identify solutions with specific performance characteristics in order to fully respond to the needs of their target context. The projects have a high strategic value due to the increase in know-how that has been achieved and to the growth in competitiveness that will follow. Below is an indication of these projects, most of which are multi-year in nature.

FiberCable4.0

The research project involves the design, development and production of highly innovative fibre optic cables for fixed installation with thermoplastic sheath, with data transmission potential 33% higher than the state of the art, in order to allow the adoption of 5G and even 6G connection technologies in the country, thus contributing to strengthen the infrastructural communication network which enables the Industry 4.0 paradigms (a project financed by the Tuscany Region as part of the Regional Operational Program ERDF 2014-2020 Call for bids no.1: Strategic Research and Development Projects);

Capacity

Development of innovative materials based on polymeric compounds including nanofillers and/or bio-based polymers, and their use for manufacturing cables for energy transport, data transport and telecommunications, characterised by improved performance and greater sustainability of the entire life cycle, thanks also to process innovations and to the design for recovery and recycling of materials (a project financed by the Tuscany Region as part of the Regional Operational Program FESR 2014-2020 Call for bids no.1: Strategic Research and Development Projects);
- Development of new Icephobic cables;
- Development of new AB-OPGW detachable safety lines with optical fibres;
- Development of new flame retardant formulations with better performance than those required by the CPR legislation and such as not to require changes in the production processes.

TRATOS HV has conducted an intense activity of Industrial Research and Experimental Development as part of a multi-year project of high strategic value for the company. The project in question, which began in 2016 and whose end (following an extension) took place in 2019, is among the projects financed by the Ministry for Business and Made in Italy within the aid project "Fondo Crescita Sostenibile - Bando Horizon 2020". Presented by Tratos HV and the Department of Chemistry, Biology and Biotechnology of the University of Perugia, it proposes a product innovation through the study and development of a new family of medium and low voltage cables for mobile laying applications (with particular emphasis on the supply of operating machines). The key aim of the project is to replace the current coating sheath, currently made of polychloroprene with the addition of equally critical substances in terms of environmental impact and safety in the workplace, with innovative nanostructured non-toxic compounds. The use of nanostructured materials must give the new compound excellent flame retardant, gas barrier properties and good mechanical properties, as required by the scope for which it is intended.

To achieve this objective, we have envisaged the adoption (as nanostructured materials) of inorganic-organic additives belonging to the chemical classes of lamellar solids such as functionalised hydrotalcites, functionalised montmorillonites and functionalised zirconium phosphates and phosphonates.

The new compound must give the cable the same characteristics ensured today by the polychloroprene sheath with the advantage of overcoming the limits and critical issues deriving from the use of traditional cable, in particular:
- the emission of toxic and corrosive fumes during combustion, in case of fire;
- the use of specialised personnel for production, as it is difficult to process, in addition to
- the high production of waste both during compounding and during retrusion.

The aim of the project is, therefore, to identify one or more completely innovative compounds which, used as a base for the new cable coating, allow achieving several results (both technical and qualitative) and that demonstrate the technological leap of the proposal. These include:
- compliance with the CPR - CEI 50399 standard, with specific reference to obtaining a fire retardant compound;
- reduction of the specific weight of the cable by about 15%;
- obtaining a production process in which the use of cross-linking agents such as ETU and antioxidants such as Premix MBTS and TMQ is no longer required;
- in case of fire, the development of non-toxic combustion fumes, according to the CEI EN 50267 standard.

TRATOS-ENEA:
100 km of superconducting cables made in Italy for international fusion projects

MASSIMO SERI
PRODUCT DEVELOPMENT MANAGER
HIGH TECHNOLOGY DIVISION

Committed to developing new energy solutions

Energy demand will undergo a steep increase in the following decades while the fossil fuel reservoirs will presumably dwindle at least as fast. Tratos contributes to a process that can guarantee a cospicuous, non intermittent and reliable energy production and researches on low carbonfoot cables.

Nuclear fusion is a very promising alternative that satisfies the requirement of having a realible energy source and is very likely to play a pivotal role in the energy arena. To date the most advanced way to harness fusion energy is represented by tokamak machines, where nuclear reactions take place within a torus-shaped plasma that must be confined in the reaction chamber by means of intense magnetic field. Many of the superconductive cables for Cadarache fusion plant was produced in Tratos Cavi.

ENEA
DTT project

Future Objectives

The Tratos Group products are some of the most important tools for progress in this world on the move. Since its foundation, the Group has been totally dedicated to the development of its cables and related components.

Today's industrial world is rapidly evolving and every day it requires performances that are faster, more resistant, more effective, more sustainable and with more advanced technologies.
Tratos always looks for the step ahead of this evolution, and with continuous investments, studies, research, planning and ideas, frequently supports guidelines for the development of latest generation infrastructural networks for energy, telecommunications and broadband.

By setting itself objectives aimed at achieving the best possible result, improving performance in a sustainable way and renovating by developing latest generation products, the Tratos Group produces and supplies materials to all operating sectors, from railways to the maritime industry, from construction to the military industry and this continuous research, this constant development, this continuous innovation are the key pillars of the company's technical-commercial success.

From 1966 to today, the company has kept faith with that vision, that mission and those ideals... those fundamental principles that have allowed the growth of the company, the well-being of the people and the support of today's global communities.

In 2015, world leaders agreed on 17 global goals (officially known as the Sustainable Development Goals "SDGs"). These goals have the potential to create a better world by 2030 by ending poverty, correcting inequalities and urgently addressing climate change. Guided by these objectives, it is now up to us to want to work together to build a better future (governments, businesses and civil society).
Tratos has adopted these objectives and incorporated them into its management culture as a "fundamental part of its corporate strategy".
"Everyone can help ensure that global goals are achieved and thus change the world".

ELISABETTA BRAGAGNI CAPACCINI
CEO OF TRATOS

Sustainable strategy

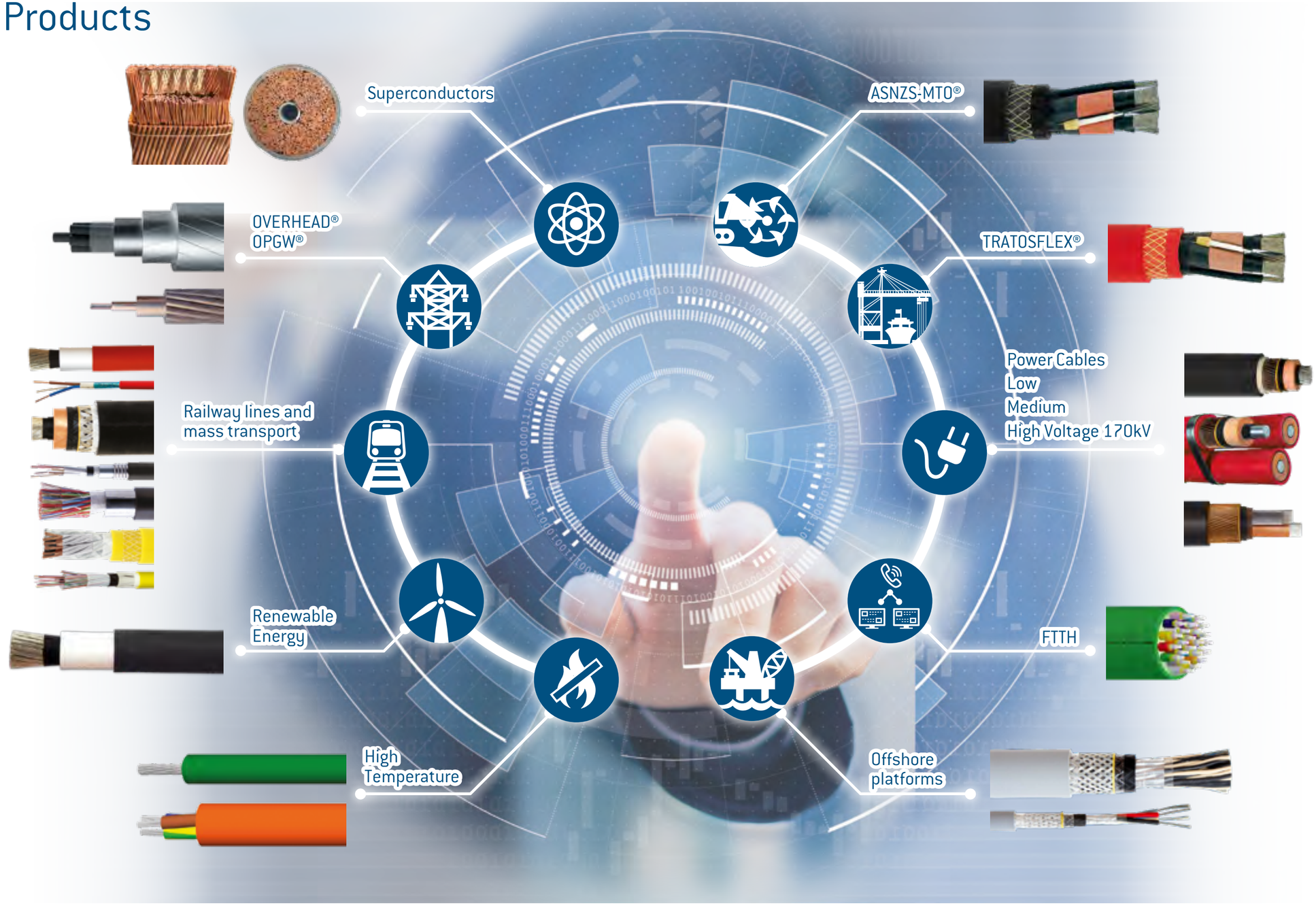
Companies like Tratos, with a global presence, must have an answer to the sustainability challenge. With foresight already decades ago, and precisely since 1980, it began to develop an energy transition using clean and renewable energy from its own "Il Pozzale" hydroelectric plant. In 2001 the company began producing Tratos Green, a cable made using exclusively hydroelectric energy.

Since its foundation in 1966, Tratos has always looked after its employees by undertaking to protect the health, integrity and well-being of workers, guaranteeing a safe workplace in compliance with the regulations in force in each individual country, never forgetting the territories and the communities in which it operates. In addition to supporting the economic result, our products are developed to improve company technology, to withstand and/or outperform the competition, taking into account all responsibilities. A great virtue of the company is the production of eco-friendly cables that connect and power the world in compliance with environmental standards and which are totally recyclable at the end of their life. In 2019, it launched its first integrated sustainability strategy and when implementing this, it committed to adopting high standards that go far beyond the legal requirements. Over the years, it has consistently achieved its objectives, excelling in demonstrating high quality social and environmental performance across its operations and in increasing stakeholder knowledge of labour practices through studies, transparency and meaningful publications.

The efforts to understand, involve and collaborate in the best possible manner with its collaborators are and will be the key to creating mutual and lasting value. Through its activities, Tratos fully supports the development program of the United Nations Agenda 2030, thus contributing to the achievement of the goals for sustainable development. Understanding how we can contribute more to climate change mitigation remains a priority, as does ensuring strong relationships with our social communities.

Over the years, the company's performance has demonstrated that a pragmatic approach, combined with high profitability, really creates lasting value for the related people: shareholders, employees and communities in the countries where Tratos is present.

Products



Markets

Power grids

Power transmission cables up to 600/1000 V, general wiring cables, underground mains cables from –1 kV to 33 kV, waveform, service cables, power transmission cables from 1.9/ 33 kV to 26/45 kV, underground network cables from –20 KV to 99 kV, bare or covered overhead line conductor and high voltage cables up to 170 kV.

Telecommunication

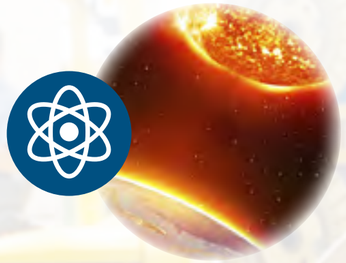
Telephone cables, LAN cables, fibre optic and coaxial cables for communication and telecommunication used in extensive applications including mobile networks, data centres, industrial and railway telecommunications systems where reliability is of paramount importance for security.
Tratos, as an innovator in the industrial cables sector, provides solutions, innovations and quality.

Special cables

Cables that can incorporate into a single finished product: power components, control, signalling and fibre optic elements.
Thanks to almost sixty years' experience in designing and manufacturing cables, the company can overcome the challenges that have to be tackled and thus provide customers with the ideal and tailor-made solutions with technical values that meet the most demanding requirements.

Standard

As a global manufacturer, Tratos maintains an updated archive with all customer specifications, as well as the standards achieved for products for national and international use.
The Group is a member of the (BCA) British Cables Association and of the Italian Association of Electrical Cable and Conductor Industries (trade associations of manufacturers of energy and telecommunications materials). *"Organisational bodies that notify the company of the initial information relating to key developments in production standards"*.



Nuclear fusion

Nuclear fusion is considered one of the most useful options to guarantee a large-scale, safe, environmentally friendly and practically inexhaustible source of energy.
The Tratos group is a member of ICAS Srl (Innovation and Consulting on Applied Superconductivity). Since 2010, the Consortium has carried out the fundamental task of designing and producing the superconductors necessary for manufacturing the magnets used to safely contain the plasma in the ITER and in the JT-60SA, experimental tokamak reactors.
Using superconducting cables, in accordance with IEC TR 61788-20, the company supplied wiring and sheathing for 20 km of ITER - TF conductors (International Thermonuclear Experimental Reactor - Toroidal Field; 28 km of JT-60SA TF plus jacket for 22 km of Poloidal Field conductors.
The headquarters of TRATOS CAVI SPA *"one of the Group's plants, a point of reference for various international agencies for research and sustainable development"*, is also used by ICAS to carry out all the cabling activities in all the other dedicated projects.

Tratosflex

Cables created for cranes and all mobile applications in continuous operation.
Investments, safety, human resources, technology, materials, durability and performance of sustainable products have led Tratos to its pre-established goal. Currently, thanks to its very high technical-functional performance, Tratosflex is present and applied in the most important world ports. These cables have been specifically designed for continuous winding on and off drums or reels and can provide power, control and signalling functions including fibre optic cables and components operating in high speed reeling applications (300 metres per minute).

Railways and transport

The company's continuous studies and analyses have allowed creating a wide range of specialised solutions for railway cables: from medium and high voltage cables for connection to substations or switchboards, to "copper and optical fibre" data and telecommunications" ones, OLE Control & Signalling Cables, Station & Premises and Pantograph & Rolling Stock rail power cables.

CUSTOMERS

• ENERGY UTILITIES

Alternativeenergies

Underground and overhead
low, medium and high voltage

Civil construction

• TELECOMMUNICATION UTILITIES

Telephoneconnections

Fibre optic
media networks

• OIL & GAS

Refineries

Mining industry
(sea and land)

• PORTS

Cables for port cranes

• MOBILITY AND TRANSPORT

Railway,
automotive and
shipbuilding
industries

Military Industries

Nuclear fusion
projects

372

TOTAL PERSONNEL EMPLOYED IN
ITALY
SPAIN
UNITED KINGDOM

86
Tratos HV

9
Tratos SRL

175
Tratos Cavi S.p.A.
Pieve Santo Stefano

53
Tratos Cavi S.p.A.
Catania

9
Tratos
Iberica

40
Tratos UK

Statistics

Financial data reports

ORIANO GREGORI
TRATOS GROUP ADMINISTRATION AND FINANCE

NET ASSETS

2022	57.000.000 €
2021	50.369.000 €
2020	45.928.000 €
2019	42.296.000 €
2018	40.449.000 €

TURNOVER

2022	180.000.000 €
2021	147.955.000 €
2020	121.859.000 €
2019	113.866.000 €
2018	128.221.000 €

ORDER PORTFOLIO

2022	230.000.000 €
2021	143.000.000 €
2020	96.825.000 €
2019	85.706.000 €
2018	74.746.000 €

EBITDA

2022	18.000.000 €
2021	11.341.000 €
2020	9.791.000 €
2019	7.846.000 €
2018	10.633.000 €

NET FIXED ASSETS

2022	61.500.000 €
2021	58.088.000 €
2020	57.852.000 €
2019	55.841.000 €
2018	52.129.000 €

Mission

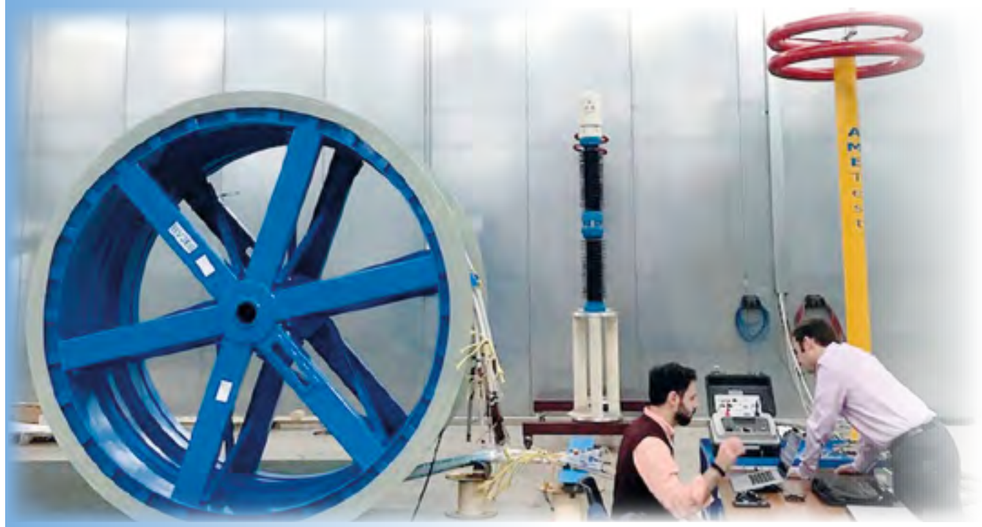
Pieve Santo Stefano boasts a thousand-year history: in Roman times it was called Suppetia and from here logs were thrown into the Tiber which then floated to Rome. The mountains served as a treasure chest of timber for the Eternal City, as Pliny the Elder tells us. Two thousand years later, instead of trunks there are copper cables, optical fibres and superconductors. The Tratos plant manufactures technology that few in the world can generate. Perhaps it is no coincidence that the Renaissance was born in the small strip of Italy around Pieve: a road sign along the Tiberina Bis informs us that Anghiari is 17 kilometres away, here Leonardo painted one of his masterpieces; the distance from Sansepolcro, the city of Piero della Francesca who invented perspective in painting on the wall of the town hall by painting the Resurrection of Christ, is even less, but also that of Luca Pacioli the inventor of double entry bookkeeping, without forgetting that 15 kilometres away there is the birthplace of Michelangelo Buonarroti. «It runs in the family» the British say when there is hereditariness. The Renaissance was the triumph of logic that has reached today in other forms: inventiveness, ability and will. In the fifties, Egidio Capaccini emigrated to Argentina and when he returned he founded Trafilerie Toscane. The breakthrough came in the late seventies. Capaccini dies suddenly and he is replaced by his daughter's husband who, at the age of just 23, liquidates the other partners and takes out a loan with Unione Fiduciaria in Milan, borrowing a very significant amount for those times and that was the moment Albano Bragagni's great adventure began. Some examples of the Tratos high technology and of its productions are the superconductors: "unique in the world, supplied for the construction of the nuclear power plant in France - ITER project", the mobile laying cables in the port of Busan in South Korea, the telecommunication network in Spain - Telefonica S.A. and the railway network of Great Britain. Everything has been created and developed from this small and remote industrial shed which has since grown and will continue to grow over the years. Pieve Santo Stefano and its people become an integral part of the company, the economy is flourishing, and thanks to Tratos who has always hired over the decades without ever firing anyone and without an hour of layoffs, still and more than ever experiences that determination, that mission by Egidio Capaccini's to "guarantee prosperity for his fellow citizens". Albano Bragagni, who carried on with this mission in addition to preserving and bringing those values to life within the company, also transmitted them by managing the town: "the trust of the people who elected him Mayor of Pieve for twenty-nine years". This small ancient world brings its benefits and in this Italy of great unfinished works and crumbling infrastructures, the Group is similar to Albert Einstein's saying: "The wing structure of the bumblebee, in relation to its weight, is not suitable for flight, but he does not know this and flies anyway". In these lands of the Renaissance, the cradle of art and of Great Beauty, a treasure of the Italian free market is almost hidden, "Tratos, a small family business for a large manufacturing company". Albano Bragagni states: «family businesses are the ones that best stood up to the pandemic, we divided tasks and powers in the company and my children Elisabetta and Ennio are both managing directors, my brother Germano looks after the Catania plant and my nephew Maurizio Tratos Ltd - UK in Great Britain», it was as simple as double entry bookkeeping and we had to do it. Our brand is recognised everywhere as a guarantee of efficiency and quality. Our feet and eyes are in many countries around the world, but the heart of the company remains in this small Tuscan town in the province of Arezzo. With the "mission" that will accompany us into the future... Bragagni continues: «I have never thought of moving the main office, because Pieve Santo Stefano is not in a bad position from a geographical and communication point of view and thanks to its central position in Italy it has multiple roads£ but the truth is, I would never have moved anyway. Here I feel the irreplaceable warmth and sweet scent of home. I met my wife in eighth grade, and we have always been together since high school. Our history has sprouted and grown in this land. We should all be aware of the beauty that surrounds us and be grateful for it. For over twelve years, every Sunday morning at seven I have met up with friends (some of whom work in the Tratos Group) and we have gone for walks along our mountain paths. Over five hours to breathe in fresh air, savour nature, be guided by freedom and beauty. I know these places like the back of my hand, yet they never cease to surprise and excite me».

I love this country, so much so that for 29 years I have held the position of mayor with commitment and passion, seeking and defending the well-being of the human capital represented by the citizens of Pieve and by our employees. Tratos sees its policy aimed at enhancing talent by equipping it with the necessary skills to create sustainable value over time and in the interest of employees, management, shareholders and all stakeholders.
It implements the national collective bargaining agreement (Italian "Rubber and Plastic" National Labour Collective Agreement), but also applies improvements deriving from internal agreements, almost sixty years of activity in the technological manufacturing sector without ever firing or laying off an employee, and without ever having to deal with union disputes or workers' strikes.
Management was difficult when the Covid pandemic broke out, there were two months during which orders had really decreased and uncertainty reigned supreme. Keeping fear and the health of our people under control was a whole new situation and we ourselves were terrified.
The priority commitment, which has always been managed to protect the integrity, health and well-being of the Group's workers, allowed us to overcome the difficult moment and as we are aware of the importance of the policy for Health, Safety and the Environment and Energy; we will continue with our commitment to guarantee a safe workplace, ensuring a systematic management approach, maintaining the relative certifications and providing training and information.

R&D "Research and Development", which has always allowed our growth, has been and will remain the backbone of our business. It has allowed us to collaborate and comply with the requests of Stakeholders, to confirm our strategic priority in energy transition processes through the evolution of the sector relating to environmental impact and to support experimental nuclear fusion projects with the related search for new particles.
In collaboration with our customers and suppliers, we have always, and today more than ever, been developing innovative materials using new plant-based compounds deriving from recycled raw materials. A perfect circular economy with a 30% lower carbon footprint than current market standards.

ALBANO BRAGAGNI
PRESIDENT OF TRATOS

Tratos cables contribute to the performance improvement of the LHC accelerator at CERN



The Large Hadron Collider (LHC) is the largest particle accelerator worldwide, developed and operational at the laboratories of the research organization CERN (Conseil Européen pour la Recherche Nucléaire – European Council for Nuclear Research), in Geneva.

The LHC, the most powerful microscope for the investigation of the matter and elementary particle physics, is hosted inside a tunnel of 27 km circumference, at about 100 m underground, across the territories of France and Switzerland. Beams of high-energy protons circulate in the accelerator ring and collide at an energy of 13 TeV (in high-energy physics, the electronvolt (eV) is used as the measurement unit of energy. 1 eV corresponds to the energy of an electron accelerated in vacuum by a 1 Volt potential difference; 1 TeV corresponds to 1000 billions of eV).

The observation of the reactions caused by the collision of two particle beams, allows to explore the deep constituents of sub-atomic matter and to reveal the important blocks of the elementary particle physics puzzle.

As a matter of fact, the researches carried out at CERN's LHC, allowed for the first time to confirm experimentally the existence of what has been colorfully defined "God's particle" (the Higgs boson, for the physicists!). The Higgs boson, considered the responsible for building the mass of any particle, was the missing link for the completion of the very important theory that describes the interaction between all elementary particles, named "Standard Model".

Thanks to this experimental observation, in 2013 the Nobel prize in Physics was awarded to Peter Higgs and François Englert, who had proposed this mechanism about 50 years before.

This result has been the outcome of an immense work of thousands of researchers and engineers from every part of the world, who have designed, built, and brought to success an unprecedented scientific and technological endeavor. Beside the great steps ahead allowed by LHC toward the comprehension of the universe and the physics of elementary particles, its development has also produced numerous industrial and technological spin-offs. The most remarkable and renowned example is the invention of the World Wide Web, born in response to the necessity to exchange large amounts of information and data among scientists spread over many countries around the globe.

In the effort to push further the advancement of science and technology, CERN researchers have now planned the new High Luminosity LHC (HL-LHC) project, that aims to increase the power of the LHC accelerator starting from 2027, thus allowing to carry out more accurate measurements of particle physics interactions, or to observe completely new phenomena.

Also concerning this last aspect, CERN is pursuing its mission, to push beyond the limits of existing technologies, and proposed the use of the magnesium di-boride (MgB2) material, never used before in such large scale and power applications. Each of the 10 Superconducting Links cables, about 100 m long, is made of an assembly of different electrically insulated sub-cables, supplying different electrical power circuits, and operates inside a flexible cryostat for the circulation of the cooling helium. Such cable should be able to carry an overall current of about 100.000 Ampere, operating at a temperature of up to 25 K, thus appreciably higher than the 1.9 K (about -270 °C) of the superfluid helium bath cooling the magnet system.

To achieve this challenging target, CERN has been working since some time to the development of new technologies, among which new superconducting magnets for particle beams bending, new optical devices and radio-frequency cavities for their focusing, and innovative superconducting cables for power transmission to the accelerator magnets from their power supplies.

TRATOS Cavi has taken up the big challenge of developing these innovative superconducting power transmission lines and has invested in the design and manufacture of cabling lines dedicated to the specific and particularly delicate handling of MgB2 wires, produced by another Italian company, Columbus Superconductors.

In fact, the high sensitivity of the performance of this material to mechanical tensile and bending stresses prevented from the use of any standard cabling machine.

After more than 2 and half years of development in collaboration with CERN, prototyping, design optimization and verification test on each of the numerous cable sub-components, TRATOS Cavi and the ICAS Consortium (Innovation and Consulting on Applied Superconductivity) have successfully completed the manufacture of the first entirely superconducting Links cable length.

The full functional test of the cable recently carried out at CERN, confirmed the expected performance and validated the MgB2superconducting cable design. This fundamental milestone toward the success of the entire project will provide a certain push toward the application of this technology for power transmission.

Author: Mr Luigi Muzzi

New superconducting technologies for the HL-LHC and beyond

Extract by CERN COURIER 2023 May/Jun

MgB2 links at the HL-LHC

The discovery of superconductivity in magnesium diboride (MgB2) in 2001 generated new enthusiasm for HTS applications. This material,classified as medium-temperature superconductor, has remarkable features: it has a critical temperature (39K) some 30K higher than that of niobium titanium, a high current density (to date in low and medium magnetic fields) and, crucially, it can be industrially produced as round multi-filamentary wire in long (km) lengths.

These characteristics, along with a cost that is intrinsically lower than other available HTS materials, make it a promising candidate for electrical applications. At the LHC the current leads are located in the eight straight sections. For the high-luminosity upgrade of the LHC (HL-LHC), scheduled to be operational in 2029, the decision was taken to locate the power converters in new, radiation-free underground technical galleries above the LHC tunnel. The distance between the power converters and the HL-LHC magnets spans about 100m and includes a vertical path via an 8m shaft connecting the technical galleries and the LHC tunnel. The large current to be transferred across such distance, the need for compactness, and the search for energy efficiency and potential savings led to the selection of HTS transmission as the enabling technology.

The electrical connection, at cryogenic temperature, between the HL-LHC current leads and the magnets is performed via superconducting links based on MgB2 technology. MgB2 wire is assembled in cables with different layouts to transfer currents ranging from 0.6kA to 18kA. The individual cables are then arranged in a compact assembly that constitutes the final cable feeding the magnet circuits of either the HL-LHC inner triplets (a series of quadrupole magnets that provides the final focusing of the proton beams before collision in ATLAS and CMS) or the HL-LHC matching sections (which match the optics in the arcs to those at the entrance of the final-focus quadrupoles), and the final cable is incorporated in a flexible cryostat with an external diameter of up to 220mm. The eight HL-LHC superconducting links are about 100m long and transfer currents of about 120kA for the triplets and 50kA for the matching sections at temperatures up to 25K, with cryogenic cooling performed with helium gas.

The R&D programme for the HL-LHC superconducting links started in around 2010 with the evaluation of the MgB2 conductor and the development, with industry, of a round wire with mechanical properties enabling cabling after reaction. Brittle superconductors, such as Nb3Sn – used in the HL-LHC quadrupoles and also under study for future high-field magnets – need to be reacted into the superconducting phase via heat treatments, at high temperatures, performed after their assembly in the final configuration. In other words, those conductors are not superconducting until cabling and winding have been performed. When the R&D programme was initiated, industrial MgB2 conductor existed in the form of multi-filamentary tape, which was successfully used by ASG Superconductors in industrial open MRI systems for transporting currents of a few hundred amperes. The requirement for the HL-LHC to transfer current to multiple circuits for a total of up to 120kA in a compact configuration, with multiple twisting and transposition steps necessary to provide uniform current distribution in both the wires and cables, called for the development of an optimised multi-filamentary round wire. Carried out in conjunction with ASG Superconductors, this development led to the introduction of thin niobium barriers around the MgB2 superconducting filaments to separate MgB2 from the surrounding nickel and avoid the formation of brittle MgB2–Ni reaction layers that compromise electro-mechanical performance; the adoption of higher purity boron powder to increase current capability; the optimisation in the fraction of Monel (a nickel-copper alloy used as the main constituent of the wire) in the 1mm-diameter wire to improve mechanical properties; the minimisation of filament size (about 55μm) and twist pitch (about 100mm) for the benefit of electro-mechanical properties; the addition of a copper stabiliser around the Monel matrix; and the coating of tin–silver onto the copper to ensure the surface quality of the wire and a controlled electrical resistance among wires (inter-strand resistance) when assembled into cables. After successive implementation and in-depth experimental validation of all improvements, a robust 1mm-diameter MgB2 wire with required electro-mechanical characteristics was produced.

The next step was to manufacture long unit lengths of MgB2 wire via larger billets (the assembled composite rods that are then extruded and drawn down in a long wire). The target unit length of several kilometres was reached in 2018 when series procurement of the wire was launched. In parallel, different cable layouts were developed and validated at CERN. This included round MgB2 cables in a co-axial configuration rated for 3kA and for 18kA at 25K (see "Complex cabling" figure). While the prototypes made at CERN were 20 to 30m long, the cable layout incorporated, from the outset, characteristics to enable production via industrial cabling machines of the type used for conventional cables. Splice techniques as well as detection and protection aspects were addressed in parallel with wire and cable development. Both technologies are strongly dependent on the characteristics of the superconductor, and are of key importance for the reliability of the final system.

The first qualification at 24K of a 20kA MgB2 cable produced at CERN, comprising two 20m lengths connected together, took place in 2014. This followed the qualification at CERN of short-model cables and other technological aspects, as well as the construction of a dedicated test station enabling the measurement of long cables operated at higher temperatures, in a forced flow of helium gas. The cables were then industrially produced at TRATOS Cavi via a contract with ICAS, in a close and fruitful collaboration that enabled – while operating heavy industrial equipment – the requirements identified during the R&D phase. The complexity of the final cables required a multi-step process that used different cabling, braiding and electrically insulating lines, and the implementation of a corresponding quality-assurance programme. The first industrial cables, which were 60m long, were successfully qualified at CERN in 2018. Final prototype cables of the type needed for the HL-LHC (for both the triplets and matching sections) were validated at CERN in 2020, when series production of the final cables was launched. As of today, the full series of about 1450km of MgB2 wire – the first large-scale production of this material – and five of the eight final MgB2 cables needed for the HL-LHC have been produced.

Superconducting wire and cables are the core of a superconducting system, but the system itself requires a global optimisation, which is achieved via an integrated design. Following this approach, the challenge was to investigate and develop, in industry, long and flexible cryostats for the superconducting links with enhanced cryogenic performance. The goal was to achieve a low static heat load (<1.5W/m) into the cryogenic volume of the superconducting cables while adopting a design – a two-wall cryostat without intermediate thermal screen – that simplifies the cooling of the system, improves the mechanical flexibility of the links and eases handling during transport and installation. This development, which ran in parallel with the wire and cable activities, led to the desired results and, after an extensive test campaign at CERN, the developed technology was adopted. Series production of these cryostats is taking place at Cryoworld in the Netherlands.

The optimised system minimises the cryogenic cost for the cooling such that a superconducting link transfers – from the tunnel to the technical galleries – just enough helium gas to cool the resistive section of the current leads and brings it to the temperature (about 20K) for which the leads are optimised. In other words, the superconducting link does not add cryogenic cost to the refrigeration of the system. The links, which are rated for currents up to 120kA, are sufficiently flexible to be transported, as for conventional power cables, on drums about 4m in diameter and can be manually pulled, without major tooling, during installation (see "kA currents" image). The challenge of dealing with the thermal contraction of the superconducting links, which shrink by about 0.5m when cooled down to cryogenic temperature, was also addressed. An innovative solution, which takes advantage of bends and is compatible with the fixed position of the current lead cryostat, was validated with prototype tests.

Bridging the gap *Shown on the left is a longitudinal cross-section of 4 mm-wide REBCO tape, pictured from a different perspective in the middle panel, and on the right is a 10 mm-diameter REBCO cable for 3 kA currents at 60 K.*

kA currents *Delivery and handling of the 120 kA MgB$_2$ cable assembly. The flexible, double-walled corrugated cryostat comprises 19 MgB$_2$ superconducting cables in a single assembly, twisted together to form a compact bundle. Each MgB$_2$ cable is about 140 m long with the bundle diameter around 90 mm.*

Adoption of recycled and bio-based materials for the production of energy distribution cables to achieve a significant reduction in CO_2 emissions

27th International Conference on Electricity Distribution - Rome, 12-15 June 2023

Development of new cable solutions and evaluation of the reduction of carbon emissions

Thee three sustainable solutions above were included in the Global Tender for cable and conductor 2021 on a selection of material codes with a higher spending for Italy and Spain.
The implementation of these initiatives were achieved thanks to three suppliers: Nexans, Prysmian and Tratos.
The cable production lines have not changed since the production process of these new solutions is identical to that of traditional cables.
The only difference from the production of the standard cables is the implementation of sustainable raw materials.
The need to track cables produced from sustainable materials requires an organization of warehouses to ensure separate storage of these raw materials and an organization of the production line in such a way that it is only dedicated to this specific product for a certain period of time.
The cables were manufactured and tested successfully according to the Enel Global Specifications.
To evaluate the environmental impact associated with their production and to compare them with traditional solutions, it was required to the Suppliers to estimate the product carbon footprint of these new sustainable solutions and to compare it with that of the standard to determine the potential carbon footprint reduction.
This calculation were carried out according to ISO14067 (cradle to gate).
For this purpose, the entire production chain is taken into account, starting with the extraction and production of raw materials and ending with the production of the cable, also including the CO2 produced during the transportation.
Considering that the cable production process is the same, the difference in CO2 emissions is due to the different input of raw materials.
The part of the cable that contributes the largest carbon footprint is the conductor material. Acting on the conductor, using recycled material, could lead to a more considerable reduction in emissions.
Furthermore, it is worth noting that even in the area of plastics, there is a difference between the CO2 emissions of bioplastics and recycled plastics as they have two significantly different origins.

For PE of vegetable origin, the CO2 absorption at the start of plant life can be considered in two ways:
1) include as negative emissions at the beginning (absorption) and sum the positive contribution at the end-of-life the greenhouse gas emissions (cradle to grave);
2) consider both the CO2 absorption contribution at the beginning of life and the emission contribution at the end of life to be zero.[4-5]

As the present analysis is based on the cradle-to-gate cycle, the contribution represented the CO2 storage of the plants was taken into account.

The following table shows the results obtained about percentage reduction in carbon footprint for four identified samples (two low-voltage and two medium-voltage examples were selected from the lot of cables). As can be seen from the table, the calculations have proved that the use of plant-based materials and the use of recycled materials leads to a reduction in CO2 emissions of up to 5%.

A greater reduction is achieved by using recycled material than by using polyolefin of vegetable origin.
Clearly, greater reductions occur in the case of cables with higher tension levels and larger cross-sections (larger amounts of material involved).

TYPE OF CABLE	CO2eq REDUCTION %	
	GREEN SOLUTION	RECYCLED SOLUTION
LV AERIAL BUNDLED CABLES 3x70+54,6 mm2 AL COND XLPE INS XLPE SHEATH AL2 MESSENGER	2,5	3,5
LV UNDERGROUND CABLE 3X150+95N AL COND XLPE INS PO SHEATH	1	3
MV AERIAL CABLES 3x50 50Y+mm2 AL COND XLPE INS PE SHEATH AL FOIL SCREEN BARE Alumoweld MESS	2,5	3,5
MV UNDERGROUND TRIPLEX CABLES 185 mm2 AL COND XLPE/HPTE INS A FOIL SCREEN PO SHEATH	3,6	5

About Us

Values

Size

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cables for a moving world

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