



Submarine Energy Systems

System Solutions and Innovation

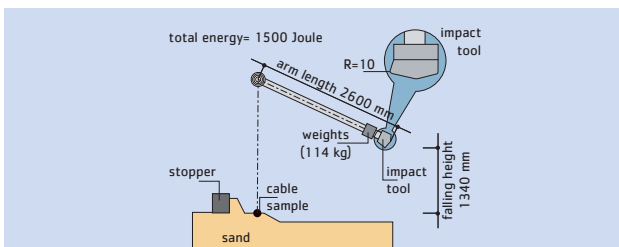
Prysmian is the acknowledged world leader – both in terms of market share and technical know-how – in the submarine systems field, which is now facing a number of new challenges: sharp increase in power demand, strong orientation towards the development of renewable energy sources and optimisation of the existing generation capacity. These factors are determining and will determine more and more in the years to come an increasing need for submarine interconnections.

On the other hand, utilities consortia are moving to higher

power transmission capacity systems and to environmentally friendly systems not only as far as the cable is concerned but also as for its installation. They also require tighter delivery times for submarine systems and acceptable returns for the investors they are financed by.

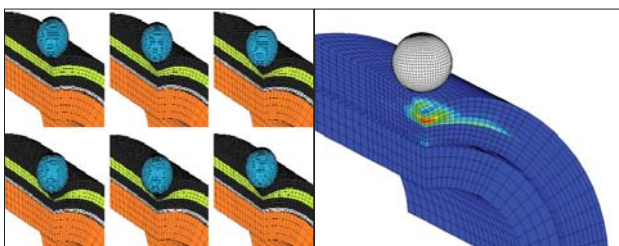
In this scenario, the total cost of the system may be the determining factor for the implementation of a project and the availability of innovative solutions together with a comprehensive know-how of all phases of the project become essential to play an important role in this market.

> AIR BAG™ Cable System

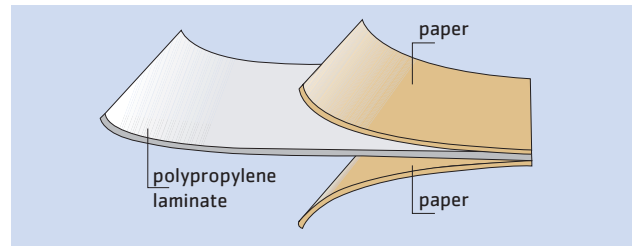


Prysmian has patented a completely polymeric innovative protection system, the **Air Bag™** Cable System, which guarantees an exceptional level of mechanical protection by absorbing the shocks and dramatically reduces the risks of permanent deformation or damage of the most sensitive underlying layers, such as screen and insulation. The **Air Bag™** technology provides cables with reduced weights and dimensions as well as longer lengths, key advantages as far as installation is concerned.

The **Air Bag™** technology (already a major breakthrough for underground applications) finds a fertile soil in energy submarine systems applications, thanks to the cables lighter weight and improved handling characteristics, where these parameters have a determining impact on the entire system, even higher than in terrestrial applications.



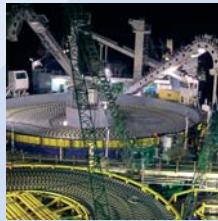
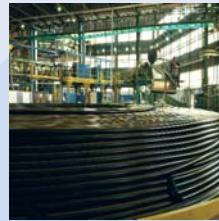
> PPL



The need of making clean energy more widely available as well as a more and more competitive energy market are challenging cable makers to develop new products and systems to economically deliver bulk power over increasingly longer distances.

So far, SCFF cables have met the requirements of carrying the highest levels of power in both AC and DC systems, whereas MI Paper Insulated cables have met the requirements of covering very long distances for DC links, typical of submarine interconnections. Nevertheless, both technologies have intrinsic limitations: the former in distance by the oil feeding hydraulic system, the latter in voltage/power by kraft paper's electrical and thermal performances. A new insulation system consisting of Paper Polypropylene Laminate (PPL) has been adopted for some years for HVAC SCFF cables, especially for voltages above 275 kV, in order to improve electrical performances and reduce losses. Now, research and development work on materials and technologies carried out by Prysmian in recent years has led to a product in which the advantages of both technologies are brought together. The use of PPL in combination with a viscous compound has significantly increased HVDC cables electrical and thermal performances and paved the way for system planners to a range of unprecedented technical and economical possibilities.

YOUR ENERGY... OUR SYSTEMS... ANYWHERE



> Offshore Wind-farms



Among the renewable energy sources presently being investigated and developed, wind energy seems the most promising.

After the expansion of windmills on land, currently there is also a considerable increase in the number of windmills being installed off-shore, mostly in Northern Europe. Offshore wind-farms require submarine cables to connect the windmills among them and to ensure the connection with the power supply network.

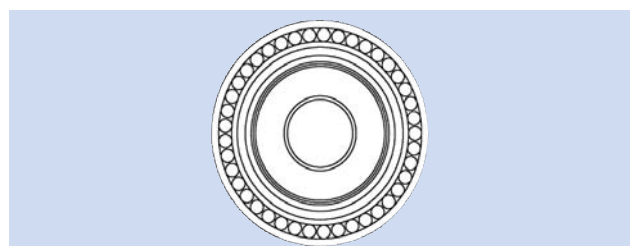
Another primary commitment of Prysmian in the field of energy submarine cables is the development, manufacture and installation of AC extruded insulation cable systems with high power transmission capacity (100 – 200 MW and above) to meet the needs of this new market, as well.



> Extruded Insulation Cables for HVDC Links



Where system requirements permit, the use of an extruded (EPR or XLPE) dielectric offers several remarkable advantages and makes for lighter and easier-to handle cables, which can operate at high temperatures (90°C) and at high electrical stresses. This technology is widely field-proven in submarine applications for medium/high voltages (i.e. up to 150 kV). Thanks to recent technology improvement this type of cable is presently adopted for voltages up to 230 kV AC. Recent studies have demonstrated that the extruded technology proves suitable also for HVDC links, in particular when associated with VSC (Voltage Source Converter) technology. Absence of pressure feeding requirements, possibility of omitting metallic sheaths, reduced cable weight and dimensions and relative ease of jointing are the key features of this technological innovation, which offers also considerable benefits in terms of total system costs.



About us

Prysmian Cables & Systems is a world-class multinational company. Founded in 1872 as "Ditta Pirelli & C.", it has achieved a leading position for more than a century of operations in its two key international markets - "Energy Cables & Systems" and "Telecom Cables & Systems".

Prysmian Cables and Systems is the world's largest manufacturer of power and telecommunications cables, with 52 manufacturing facilities in 21 countries in five continents and a market share in excess of 10%.

Prysmian Energy Cables and Systems is a global solutions provider, offering a wide range of integrated solutions, such as cable systems, system design and engineering, project management, installation and post-sale services.

Prysmian Energy Cables and Systems concentrates on continuous product innovation and on achieving a competitive edge by focusing on research and development. This is done through Prysmian's own R&D centres and by co-operating with universities, scientific institutions and above all, our customers. Prysmian's world-wide organisation makes and delivers advanced technological solutions to customers anywhere in the world.



Global Solutions Provider

The energy market has been changing dramatically in recent years, as a result of deregulation and privatisation. To face the challenge of competition, energy transmission and distribution operators are driven towards an optimum use of their existing resources and new investments.

To support its customers, Prysmian has evolved over the years from the traditional role of cable manufacturer to that of a **Global Solution Provider**. Prysmian focuses on a total system approach, to give its customers the lowest cost of ownership of their new and installed cable networks.

This "Total System" approach is, at all voltages, the ultimate solution to provide power utilities with real advantages in terms of asset optimisation. Besides an increasing activity on product innovation to lower investment costs, Prysmian is developing additional pre and post sales services for its customers - e.g. network services, enhanced logistics, engineering studies - to optimise asset management and give the best possible exploitation of transmission and distribution networks.



Product Range

Electrical feeding of islands from the mainland or a major island of an archipelago, interconnections between HV networks for possible transfer of electrical power in both directions, transfer of cheap power generated on natural or artificial islands to the mainland,

crossing of sea inlets and rivers, connection to or between offshore oil production facilities are the most common applications of submarine cables in power transmission and distribution systems.

> Mass Impregnated Cables



These cables are presently suitable for voltages of up to 45 kV AC and 500 kV DC. The insulation consists of high-density paper tapes impregnated with a high-viscosity compound which does not require fluid pressure feeding, thus allowing these cables to be installed in HVDC links in very long lengths, up to several hundreds of kilometres. Present experience or trials are limited to water depths in the range of 1000 m, but deeper waters can be reached by using special design features.

> Self-Contained Fluid Filled Cables



These cables are presently suitable for voltages up to 600 kV DC and 1000 kV AC. They can be laid at depths down to approximately 800 m without special precautions; with the use of special fluids and proper armour designs, depths of 2000 m can be reached as demonstrated by the Hawaii Deep-Water Cable development program. SCFF cables designs depend on the feeding length – max. connection lengths are of between 60 to 100 Km, depending on system features: the longer the route, the larger the oil duct required.

In three-core constructions each core has a compact stranded conductor insulated with paper tapes; the cores and oil ducts are laid up together under a common metallic sheath.

Paper-Polypropylene Laminated (PPL) Cables

PPL cables use a special low permittivity – low loss insulation type, which allows to increase the transmitted power or to reduce the conductor size and cable dimensions at the same power in comparison with conventional Self-Contained Fluid Filled paper insulated cables. The use of PPL is in general considered for large sizes and for HVAC voltages above 275 kV.

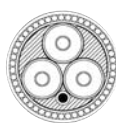
> Extruded Insulation Cables



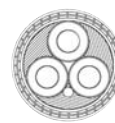
HVDC



HVAC



MV



The extruded dielectric offers many advantages, which make the cables lighter and easier to handle and to install. Both EPR and XLPE can be used for insulation: they provide the cables with the advantage of operating at high temperatures (90°C) and at high electrical stresses. In most cases, XLPE requires an impervious metallic sheath (e.g. lead sheath) to be applied over each core to avoid direct contact with water. EPR compounds can be formulated in such a way as to give an excellent performance in terms of both electrical reliability and ageing, thus removing the need for an impervious metallic sheath (the so called "Wet Design").

> Accessories

For all types of submarine cable systems, Prysmian offers a complete end-to-end system, including all types of accessories.

High Voltage Paper Insulated Cables

Main accessories include: Indoor Terminations and Outdoor Terminations, Repair and Transition Joints, Armour Clamps and Pumping Stations (only for Self Contained Fluid Filled Cables, to feed the cable through the end terminations with a continuous flow of oil (sometimes for several weeks) sufficient to cope with the transient pressure/volume, and continuous (sometimes for several weeks) to avoid any water penetration into the cable in the event of a damage).

Extruded Insulation Cables

Ease and rapidity of installation to reduce vessel time and capability of withstanding high mechanical stress levels during deployment are the basic accessories design requirements for this type of applications (mainly MV cables for offshore oil industry).

Main accessories include: Pulling Heads, Armour Hang-offs, Platform Joints, Repair Joints, Subsea Terminations and J-Tube Seals.

Project Management and Services

These key features play a fundamental role in the life of the system and are strictly interdependent. It is therefore important to conceive and design the system as a whole.



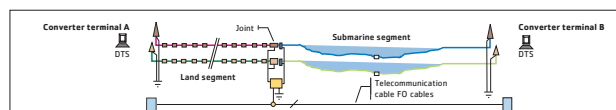
> Project Management

Prysmian's ability to supply and install complete cable systems would not be possible without a strong commitment to a high quality management of the project, which is achieved thanks to specialist Project Managers appointed upon the award of a contract. A Project Manager assembles a team of experts in the various disciplines required by the project and is responsible to ensure that the project comes in on time, pursuant to the customer's specifications and on budget.

The team will supervise the project from the planning phase, carried out with the support of software management packages, throughout the manufacturing and installation stages, to the delivery of the final project documentation.

> Engineering

Prysmian Submarine Energy Systems are characterised by a competent and experienced approach to global turnkey solutions, with improved engineering research and manufacturing resources. The advantages this organisation can offer are a strong engineering capability able to solve, develop and even anticipate the most innovative and demanding needs of the market with a particular care for the economic aspects.



> Survey

A correct analysis of all data categories (seabed topography and morphology, weather characteristics, sea currents, tides, etc.) collected during the marine survey, will result in an accurate definition of the route and of the procedures of laying, repair and protection of the cable. It will also result in a safe system design. Prysmian expertise covers all of these phases, it being capable not only to provide well-proven solutions but also specially designed alternatives.



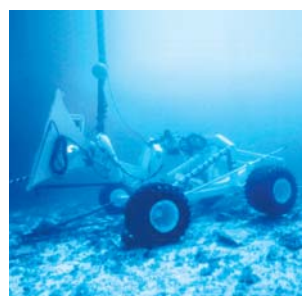
> Installation

As far as installation services are concerned, C/S "Giulio Verne" - a modern and versatile cables ship capable of laying all types of submarine cables even under severe weather and environmental conditions - is one of Prysmian's most remarkable assets. It is equipped with a 7,000 tons turntable for high voltage cables and for anti-torsional cable designs and with a capstan machine capable of operating with a pulling tension of 55 tons. The ship is also set up to simultaneously lay up to three cables in bundle configuration. Thanks to its Dynamic Positioning System - SIMRAD SDP 21 - the vessel can follow a predetermined route with extremely high accuracy. Prysmian has also the necessary in-house equipment and skills to provide additional cable-laying solutions with a wide range of vessels, both in shallow and deep waters. Trenching and embedding machines are also available for cable protection.

For each single project, the machines are chosen on the basis of the seabed morphology and depth. Where necessary, either specific equipment is designed and produced, or the existing one is modified to cope with unusual conditions.

> Post-sale and Maintenance

Post-sale and Maintenance Services are provided with the support of proper procedures, techniques, equipment and vessels or barges in order to cover all possible situations and needs. The adopted solutions are chosen on a case-by-case basis by taking into consideration both the technical and the economic aspects.



Total Quality Commitment

The Prysmian Submarine Energy Systems business unit is characterised by a competent and experienced approach to global turnkey solutions with improved engineering, research and manufacturing resources. It gathers all critical functions in a co-ordinated management structure with a common commercial policy. The main advantages this organisation can offer are: great manufacturing flexibility, strong engineering capabilities to solve, develop and even anticipate the most innovative and demanding needs of the market, installation service with extensive experience, and total quality commitment.

The Prysmian brand has always been a guarantee for the supply of products and services based on worldwide common quality standards. Prysmian has a built-in multi-step quality assurance program, which covers the entire production process from cable design and raw materials purchasing, to final inspection and testing documentation.

Prysmian business locations and manufacturing sites as well as operation units are certified according to **ISO 9001 and ISO 14001 Quality Management System standards** for their specific activities and products, and environmental quality standards.

Standards and Recommendations

Submarine cables and systems business are tailored-designed on the basis of the single projects' specific electrical and environmental parameters. Besides, international scientific bodies – like Cigré and IEC – develop relevant technical recommendations and guidelines within their activities in the field of High Voltage.

Prysmian relies on a long-standing tradition of participation and on a strong presence within such bodies, acquired thanks to its undisputed expertise developed over scores of projects accomplished anywhere in the world.



References Track Record

Year	Project	Technical characteristics	Customer
2006	Victoria-Tasmania Interconnector The longest HVDC submarine energy system	295 Km - Paper Insulated 1x1500 mm ² + Metallic Return + FO - 400 kV DC	Basslink Pty Ltd (National Grid Transco.)
2005	SAR.CO (Sardinia - Corse) One of the biggest three-core extruded AC submarine power cables existing on the market	15 Km - XLPE insulated - 3x400 mm ² + FO - 150 kV	EDF, France / TERNA, Italy
2003	SEAS - Rødsand Avmollepark (DK) A milestone in terms of linking the coast to the world's largest offshore windmill park, the Energy E2 Nysted at Rødsand	21.5 Km - XLPE insulated - 3x760 mm ² + FO - 132 kV	SEAS Group
2001	Venice - Murano - Mestre A milestone in terms of extremely low environmental impact	24.6 Km - EPR insulated - 1x1000 mm ² - 150 kV	ENEL Distribuzione
2000	Isle of Man - U.K. Mainland link The longest HVAC submarine energy system	105 Km - XLPE insulated - 3x300 mm ² - 90 kV	MANX Electricity Authority - National Grid Co.
2000	Italy - Greece The deepest HVDC submarine energy system (max depth 1000 m in the middle of the Otranto channel)	163 Km - Paper Insulated - 1x1250 mm ² - 400 kV DC	ENEL
1997	Korea Mainland and Cheju Island link A milestone in terms of challenging installation conditions	101 Km - Paper Insulated - 1x800 mm ² + FO - ±180 kV DC	KEPCO
1996	Nantucket Island - New England link A milestone in terms of extremely low environmental impact	43.4 Km - EPR insulated - 3x500 KCM + FO - 46 kV	New England Power Co.
1996	Penang Island - Malaysia link A major achievement in terms of delivery: despite the extremely tight timeframe - 12 months - the project was delivered one month earlier	6x14 Km - SCFF - 1x800 mm ² - 275 kV	Kumpulan Pinang Usahasama Imbas Setia
1995	Spain - Morocco link A milestone in terms of depth (615 m), at that time	2x26 Km - SCFF - 1x800 mm ² - 400 kV	REE, Spain / ONE, Morocco
1990	Long Island Sound Crossing (U.S.A.) A milestone in terms of size and weight	4 x 13 Km - SCFF - 1x2000 AWG - 345 kV	New York Power Authority
1984	Crossing of the English Channel Opening of the Southampton Plant	4 x 50 Km - Paper Insulated - 1x900 mm ² - ±270 kV DC	CEGB - Guildford
1984	Vancouver Island link A milestone in terms of transmitted power (1200MW) and voltage	3 x 40 Km - SCFF - 1x1600 mm ² - 525 kV	B.C.H. & P.A. - Vancouver
1981	Crossing of the Messina Straits A major achievement in terms of severe installation conditions (seabed and currents)	4 x 6.8 Km - SCFF - 1 x 1600 mm ² - 400 kV	ENEL - Rome
1973	Mallorca - Menorca link A milestone in terms of length, 4 single lengths of 42 Km each, without any jointing	4 x 42 Km - SCFF - 1 x 500 mm ² Al - 132 kV ac ± DC	GESA - Barcelona
1965	Italy mainland - Sardinia - Corse link First cable manufactured by the Arco Felice plant. The cable is still operating	119 Km - Paper Insulated - 1x420 mm ² - ±200 kV DC	ENEL - Rome

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