525 kV extruded HVDC cable system
Doubling power transmission over longer distances
The world’s first
525 kV extruded HVDC cable system

Doubles transmission capacity over longer distances keeping the losses on the same low levels. This enables greater integration of renewables and power interconnections to the grid.

ABB’s 525 kV extruded HVDC cable system
The most recent innovation in ABB HVDC cable technology is the record-breaking 525 kV extruded HVDC cable system. By utilizing a new cross-linked polyethylene (XLPE) insulation material for extruded HVDC cable applications as well as a number of newly developed accessories the system enables power transmissions at significantly higher voltage levels than previously possible.

The first extruded 525 kV high-voltage direct current (HVDC) cable system in the world is a result of ABB’s continuous investment in development of innovative technology. It is in line with the qualification process according to international standards and recommendations.

A key step towards greater utilization of renewables
The new ABB cable system is a key element in the developing vision of a DC grid that can utilize renewable energy generation more efficiently. A single pair of 525 kV extruded HVDC cables, each cable with the diameter of a compact disk (CD), can transmit enough power from large offshore wind farms to supply approximately two million households.

Utilization of the extruded HVDC cable system technology is advantageous when power needs to be efficiently delivered through populated or environmentally sensitive areas or in coastal or open-sea applications. HVDC cable links are essential components of future sustainable energy systems required to transmit vast amounts of electricity over very long distances e.g. across and between continents.
The 525 kV extruded HVDC cable system has a possible power rating of up to 2600 MW and is ideal for delivering large amounts of electrical power from demanding offshore applications such as wind farms. The cable system is also an essential component of power grid interconnections.

**Offshore Wind Farms**

ABB utilizes extruded HVDC cable systems to connect remote wind farms to mainland grids. In order to link near-shore wind farms to mainland high-voltage alternating current (HVAC) cable systems are used. HVAC cables are also used when linking a wind farm cluster to an HVDC offshore converter station.

**Undergrounding**

ABB supplies HVDC and HVAC underground cable systems using a vast amount of experience for this application. Underground cable systems can efficiently replace or partially substitute overhead lines in challenging urban settings or sensitive environments.

**Grid interconnections**

Grid interconnections can be utilized to transfer power across and between countries helping to reduce system losses, increase transmission capacity, improve power quality, and integrate more renewable power into the energy mix. Subsea HVDC power cables of extreme length are now being used to connect distant autonomous grids.
Advantages
50% more power over extreme distances

This next generation long distance HVDC cable system includes a 525 kV voltage rating and extruded insulation

Quantum leap in cable technology
ABB’s 525 kV extruded HVDC cable system transmits power at significantly higher voltages than previously possible. By utilizing cables using an innovative extruded insulation material a 50 percent increase of power transmissions over long distances are enabled while keeping the same low transmission losses as before.

This innovative ABB cable system has a possible power rating of up to 2600 MW and is designed for both submarine and underground applications. The 525 kV extruded HVDC cable system also provides the lowest cable weight per installed MW of transmission capacity, contributing to a reduction of capital as well as operational expenses.

Insulation material
The cable insulation material is based on an unfilled XLPE system using unique Borlink™ proprietary technology. This cutting-edge material is the product of a year-long collaboration between ABB and Borealis, a leading manufacturer of polyethylene and polypropylene products. This solution requires state-of-the-art production facilities able to ensure the highest levels of cleanliness in order to attain the next level of electrical performance.

The insulation has a low DC conductivity. This is a key property in order to avoid electrical failure from a thermal runaway process at high electric stress.
The 525 kV extruded HVDC cable system meets all international standards and recommendations for extruded cable systems, including the extensive qualification type tests and long-term PQ (pre-qualification) tests. ABB has excellent in-house facilities and the equipment required to perform necessary cable system tests.

The ABB 525 kV extruded HVDC cable system includes essential accessories as:

- Prefabricated joints for both underground and subsea installations
- Flexible factory joints to achieve long delivery lengths for submarine installations
- Self-supporting cable terminations with polymeric insulators

Cable joints
The technology used to develop the cable joints for the 525 kV extruded HVDC cable system utilizes former technological experience combined with leading-edge developments and utilization of a new insulation material devised for the system. The flexible factory joints enables production of long delivery lengths for submarine installations.

Longer lengths of cable reduces the number of joints prepared on site decreasing both installation time and cost. Due to this, the limitations of delivery length only depends on loading capacity of the installation vessel.

ABB’s pre-molded, factory-tested joints comprise a sophisticated, patented, electrical stress-relief control system that has been used in thousands of installed joints, accommodating copper or aluminum conductors.

Specific transition joints enables connection of cables of different sizes and conductor materials.

Cable terminations
The self-supporting cable terminations with polymeric insulators are based on ABB bushing technology eliminating the risk of explosion shrapnel for maximum safety. These can be connected to overhead bus bars either outdoors or indoors. The hydrophobic surface is more resistant to contamination compared to traditional porcelain surfaces. To prevent burning or contamination of soil the termination is filled with dielectric gas. Electric stress control is provided by elastomeric elements that have highly nonlinear electric properties.

Installation
The 525 kV extruded HVDC cable system is robust and can be installed in virtually any environment. The laminate of the underground cables is resistant to vibration fatigue, which enables cable system installation for instance close to heavy traffic.

Direct trenching as well as duct installations are possible for the underground application. Trenches occurring during the installation process can be refilled with natural soil, cable sand or other thermal backfill material after cable pulling, leaving no trace behind.

ABB provides containers specifically constructed for assembling joints on-site. These are of high importance in order to maintain a high degree of cleanliness and control during the jointing process.
First to market
Another ABB landmark in HVDC cable technology

The 525 kV extruded cable system is the latest in a long line of HVDC technology innovations from ABB, which includes the world’s first HVDC submarine cable transmission system in 1954, and the world’s first extruded HVDC cable transmission system for underground and submarine applications.

<table>
<thead>
<tr>
<th>Project name</th>
<th>Location</th>
<th>DC voltage</th>
<th>Insulation</th>
<th>Year</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gotland 1</td>
<td>Sweden</td>
<td>100 - 150 kV</td>
<td>MI</td>
<td>1954</td>
<td>Worlds first commercial submarine HVDC cable</td>
</tr>
<tr>
<td>Baltic Cable</td>
<td>Sweden-Germany</td>
<td>450 kV</td>
<td>MI</td>
<td>1994</td>
<td>Highest voltage, longest cable length</td>
</tr>
<tr>
<td>Gotland</td>
<td>Sweden</td>
<td>80 kV</td>
<td>XLPE</td>
<td>1999</td>
<td>Worlds first commercial HVDC extruded underground cable link</td>
</tr>
<tr>
<td>Murray Link</td>
<td>Australia</td>
<td>150 kV</td>
<td>XLPE</td>
<td>2000</td>
<td>Longest (180 km) underground cable transmission system</td>
</tr>
<tr>
<td>NorNed</td>
<td>Norway-Netherlands</td>
<td>450 kV</td>
<td>MI</td>
<td>2008</td>
<td>Longest (580 km) subsea high-voltage power cable system</td>
</tr>
<tr>
<td>SouthWest Link</td>
<td>Sweden</td>
<td>300 kV</td>
<td>XLPE</td>
<td>2015</td>
<td>First extruded HVDC system combining cables and overhead line</td>
</tr>
<tr>
<td>NordBalt</td>
<td>Sweden-Lithuania</td>
<td>300 kV</td>
<td>XLPE</td>
<td>2015</td>
<td>Longest (400 km) extruded HVDC subsea and underground cable system with cost-saving Al conductor</td>
</tr>
</tbody>
</table>

Over the years, ABB has continually expanded the limits of HVDC transmission technology by developing groundbreaking solutions that set new performance records. With the latest achievement, ABB is once again expanding the limits of extruded HVDC capability - from a maximum transmission capacity of 1500 MW at 320 kV to record-breaking 2600 MW at 525 kV – an increase of over 50 percent.
ABB
A global leader in high-voltage cable systems

ABB is one of the world’s leading suppliers of high-voltage cable systems and installation services. Providing an unrivaled expertise in a wide range of applications including offshore wind, oil and gas platform power links, submarine interconnections and the integration of renewables to the grid.

With experience of power cable expertise dating back to 1883, ABB has built a pioneering track record of manufacturing the most efficient, reliable and powerful high voltage cable technologies for submarine and underground cable applications. The portfolio includes the world’s longest and most powerful AC and DC power cable systems and a number of record-breaking innovations.

Connecting autonomous power grids to improve stability and resource utilization is an idea that has been pursued since the 1960s. Today, connecting power facilities across bodies of water is again the focus of attention, as offshore oil and gas production installations look for shore-generated power, and offshore wind parks look for efficient ways to deliver green power generation to onshore power grids. Quality, reliability and a long, trouble-free operating life are the hallmarks of ABB High Voltage Cables, which are the result of extensive, ongoing product development and world class manufacturing standards at ABB’s state-of-the-art cable factory.