Tunisia-Italy Power Interconnector Project

Environmental and Social Impact Assessment (ESIA)

Section 3 – Project definition

Draft for Consultations

JV HPC – IDEACONSULT – PROGER – ELARD - PLEXUS

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1. INTRODUCTION

The ELMED project entails the realization of a new bidirectional HVDC (High Voltage Direct Current) submarine electricity interconnection between Tunisia (Cap Bon) and Italy (Sicily), with a transmission capacity of 600 MW. The project is promoted and will be carried out by TERNA (Italian Electricity Transmission System Operator) and STEG (the Tunisian energy utility and Electricity Transmission System Operator).
The overall objective of the project is to increase the interconnection capacity -and thus the security and sustainability of supply- of the Euro-Mediterranean system by creating a link between the European and Northern African energy systems.

1.1 Project development

The Italian Transmission System Operator (TSO), TERNA (Rete Elettrica Nazionale S.p.a) and the Tunisian energy utility STEG (Société Tunisienne de l'Eléctricité et du Gaz), started cooperating for the development of a project connecting the Italian and Tunisian electrical networks at the end of 2000s.
On 29 June 2007, the Italian and the Tunisian government signed a joint declaration assigning TERNA and the Société Tunisienne de l'Eléctricité et du Gaz (STEG) the task of developing a project for the interconnection of the electricity systems of the two countries. For this purpose, STEG and TERNA founded the joint (50%-50%) company - under Tunisian law - Elmed Etudes Sarl, with the mandate of carrying out all necessary studies and preliminary activities for the construction of this electricity infrastructure.
Since then, the studies carried out have identified the preferred option as a high-voltage direct current undersea cable connection with nominal power of 600 MW between two converter stations to be built at Partanna (Sicily) and on the Cap Bon Peninsula (Tunisia).
On 30 April 2019, the Italian Ministry of Economic Development and the Tunisian Ministry of Industry established an agreement with the aim of supporting TERNA and STEG in the interconnection project. Ratified by Tunisia on 29 January 2020 and by Italy on 19 December 2021, the agreement came into force on 25 January 2022.
On 22 October 2019, TERNA and STEG signed a Memorandum of Understanding, with the intention to intensify their industrial collaboration in the area of electrical infrastructure and in particular for the project for a 600 MW HVDC undersea connection between Italy and Tunisia.
Given its strategic importance for the energy security & sustainability of the two countries and for the creation of a Euro-Mediterranean electricity grid, connecting the countries of North Africa to one another and to Europe, with a view to full integration of the markets, in accordance with Regulation (EU) 347/2013, the project was added to the third list of Projects of Common Interest (PCI) by the European Commission and confirmed in the fourth and fifth lists of PCI.
The project was included in the Italian National Transmission Grid Development Plan from 2016, as well as in the European Network of Transmission System Operators (ENTSO-E) Ten Year Network Development Plan (TYNDP) of the European Network of Transmission System Operators (ENSTO-E).
The recently issued Regulation (EU) 2022/564 of 19 November 2021 and its ANNEX VII "THE UNION (5th) LIST OF PROJECTS OF COMMON INTEREST ("UNION LIST")" defines the ELMED project (No. 2.33) as an "Interconnection between Sicily (IT) and Tunisia node (TU) [currently known as "ELMED"] (No 3.27 on the fourth PCI list)" under "The Union List of Projects of Common Interest - Priority Corridor North-South Electricity Interconnections in Western Europe ("NSI West Electricity")".

1.2 General overview of the project

The project involves the creation of a new a high-voltage DC cable interconnection between Italy and Tunisia, partly laid undersea and partly laid underground, between the existing electrical substation of Partanna (Trapani) on the Italian side and the new substation of Mlaâbi on the Cap Bon peninsula in Tunisia.

At the ends of the connection, both on the Italian side and the Tunisian side, there are plans for the creation of a converter substation, which will in turn be connected to an existing substation of the National Transmission Grid with appropriate underground or overhead alternating-current (HVAC) lines.
The following figure shows the electrical diagram of the project.

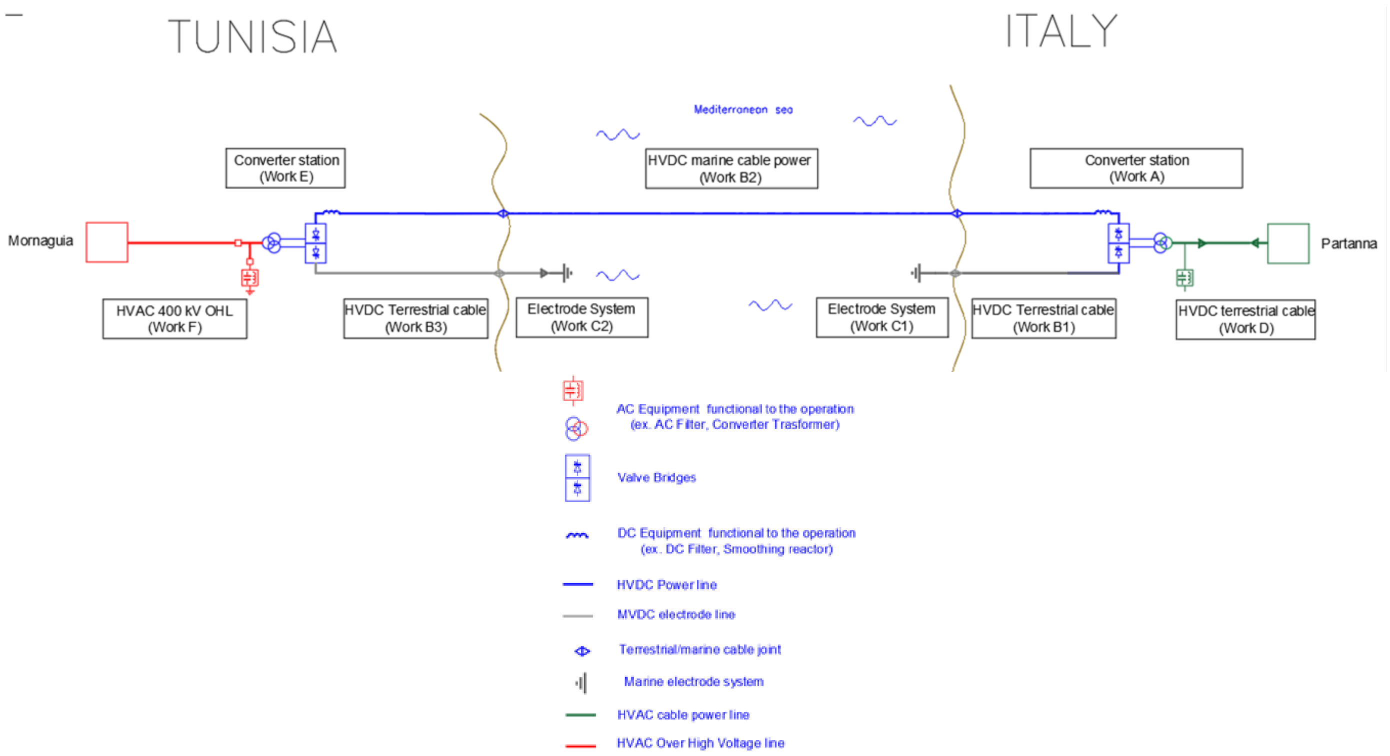


Figure 1.1: Electrical diagram of the project

The connection will have a nominal power of 600 MW and nominal DC voltage at +/- 500 kV.
The project components planned for the implementation of the HVDC connection and for the HVAC lines for connection to the national grids are summarized hereafter and presented in the following paragraphs:

1. Component A: an AC-DC converter station in Italy
2. Component B: a monopolar power connection via underground cable and undersea cable, composed of:
    - Component B1: an underground pole and electrode cable connection between the new converter substation in Italy and the landing site situated in Marinella di Selinunte, in the municipality of Castelvetrano (total length approx. 18 km). Here a joint box will be installed connecting the underground cable and the undersea cable.
    - Component B2: an undersea-cable pole connection, with a length of approximately 200 km between landing sites on the Italian and Tunisian coasts.
    - Component B3: an underground-pole and electrode cable connection between the new converter substation in Tunisia and the landing site situated in the municipality of Kelibia (total length approx. 6 km), where a joint box will be installed connecting the underground and undersea cables and the undersea cable.
3. Component C: An electrode system composed:
    - Component C1: in Italy, of a section in undersea cables stretching for approximately 12 km that, starting from the land-sea joints with the underground electrode cables, will connect to the undersea electrode to be created in the sea approximately 5 km from the coast.
    - Component C2: in Tunisia, of a section in undersea cables stretching for approximately 10 km that, starting from the land-sea joints with the underground electrode cables, will connect to the undersea electrode to be created in the sea approximately 4.5 km from the coast.
4. Component D: a connection running approximately 2 km in 220 kV double-circuit underground cable to link the new converter substation in Italy with the existing Partanna substation, the 220 kV yard of

the existing substation which will be adequately updated to enable the connection of the 220 kV cables to the Italian transmission grid.

5. Component E: an AC-DC converter station in Tunisia
6. Component F: two 400 kV overhead lines with a length of approximately 113 km that will connect the converter substation area with an existing hub on the transmission grid of Mornaguia

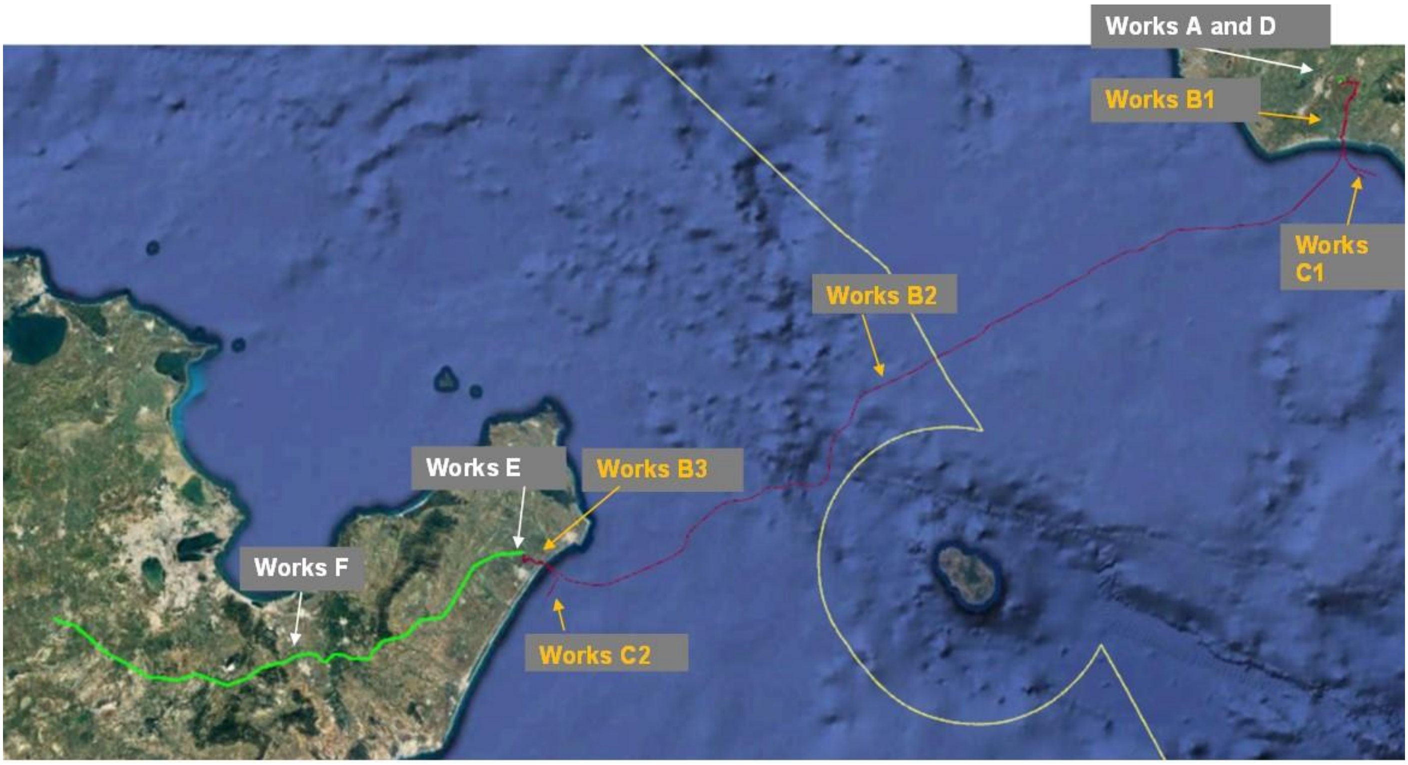


Figure 1.2: General overview of the project components

The location of all the project components was defined taking into consideration the following basic planning principles:

1. limitation of land use, giving preference to areas that are already built on;
2. limitation of the length of cable connections, to minimize impacts on local areas during works;
3. minimizing use of overhead lines;
4. site accessibility (substations);
5. minimizing environmental impacts;
6. minimizing interference with existing subservices and infrastructure.

It is important to note that ***all project components on the Italian side, both terrestrial and marine, are considered as Associated Facilities for the project,*** because even though they will not be financed by the Bank, they are directly and materially related to the project, necessary to its viability and will be carried out contemporarily with the project preparation and implementation and thus meet the requirements of paragraph 11 of ESS1 of the ESF***.***

The following paragraphs illustrate the technical characteristics of the planned works.
It should also be noted that because the project features significant technical complexity, the elements here illustrated may undergo adjustments in subsequent design stages and during construction, also depending on available technological solutions and solutions adopted by the supplier of works.

1.3 Territorial context

- Menzel Temime (Nabeul Governorate) for:
  - The new converter substation (Project Component E)
  - HVDC terrestrial cable connection (pole and electrode) (Project Component B3)

With reference the 400 OHL line see next table.

Table 1.1: Administrative units crossed by the OHL

Governorate	*Delegation*	*Sector (Imada)*	*Lenght (km)*
Nabeul	Menzel Temime	Beni Abdelaziz	69 km
		Skalba	
		Lezdine	
		El Ouediane	
		El Asfour	
	El Mida	El Mida	
		Oum Dhouil	
	Korba	Beni Ayache	
	Menzel Bouzelfa	Errahma	
		Menzel Bouzelfa Nord	
	Beni Khalled	Bir Drassen	
		Beni Khalled Echarkiya	
		Beni Khalled Sud	
		Zaouiet Djedidi	
		El Kobba El Kebira	
	Grombalia	Nianou	
		Grombalia Est	
		Chammes	
		Khanguet El Hojjej	
Ben Arous	Mornag	Kabouti	26.5 km
		Djebel Ressas	
		El Kessibi	
		El Gounna	
		Ain Rekad	
		Oudna	
	Mohamedia	Sidi Frej	
Zaghouan	Bir Mchergua	Jebel Oust	9.5 km
		Ain Asker	
Manouba	Mornaguia	El Fejja	8 km

2. DESCRIPTION OF TERRESTRIAL PROJECT

2.1 Converter station

2.1.1 Location

The power interconnector project includes the construction of a new AC/DC Converter Station in Mlaâbi to connect the Tunita project and the national grid through an overhead transmission line. The new converter station (CS) will be located in Mlaâbi, in the Municipality of Menzel Temim, in the province of Nabeul.

The total area occupied by the station will have a surface of 100,000 m^2; the area is located in a future industrial zone, which will be developed by the Agence Foncière Industrielle (AFI), and which covers a total area of 60 Hectares.

This station will form the Tunisian terminal of the new connection and will be formed of alternating/direct conversion modules and equipment necessary for the connection with the sections of the existing transformer station.

The following figures shows the main components of the HDVC part of the project: the converter station (polygon in yellow inside the red one, which is the industrial zone of Mlaâbi) and the proposed line route for the underground cable (in yellow).

Figure 2-1: Urban planning for the Mlaâbi area

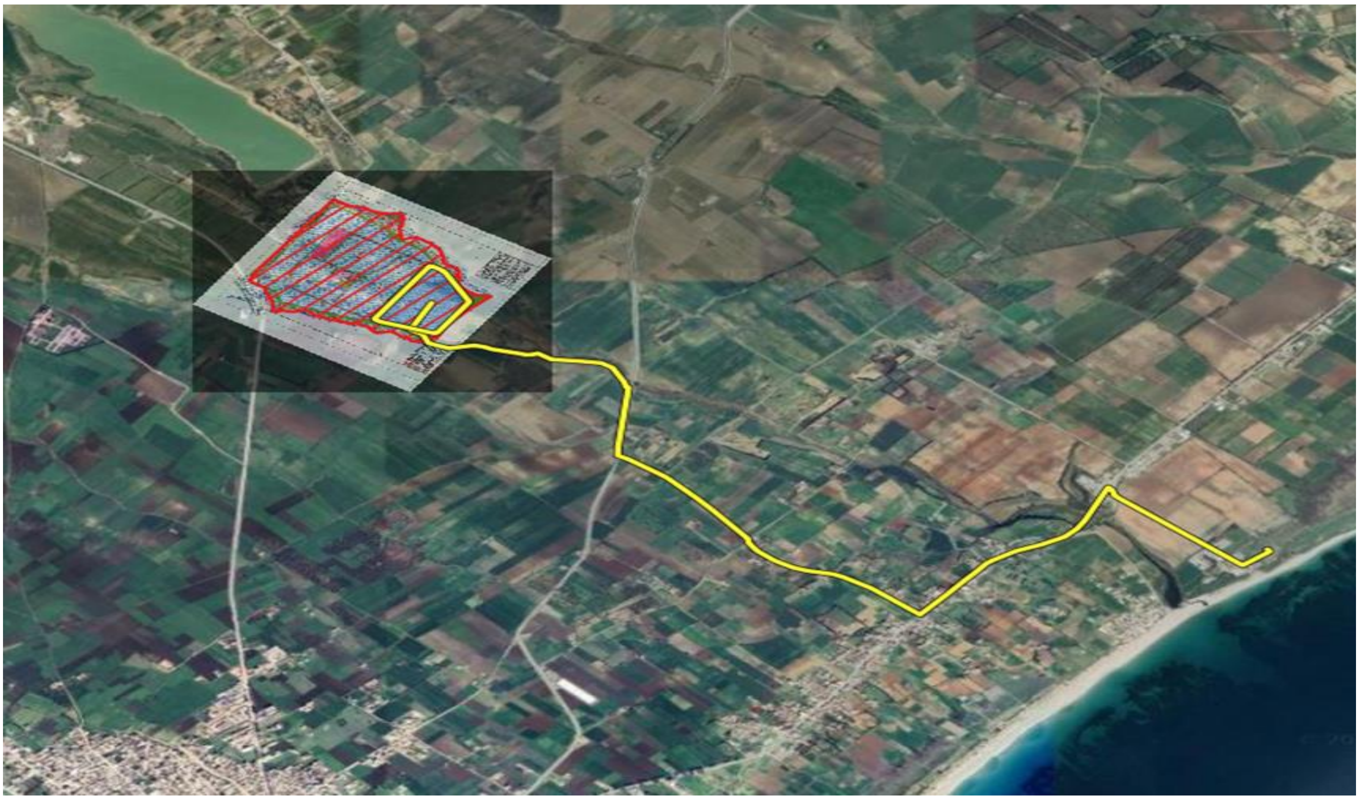


Figure 2-2: Converter station area and HVAC cable route

The main transport infrastructure linking the new industrial zone of Mlaâbi to the nearest agglomerations (Menzel Temime, Sidi Jamel Eddine) is based on road network. The CS area is accessible through the major regional road RR45 linking the city of Menzel Temime (RR27) to Zouiet EL Mgaiez (RR26).
The area is currently used for agriculture purposes. A company uses the land to produce feed (annual crops) for livestock through a rental contract with the Ministry of Agriculture. This land was transferred to the Industrial Land Agency (Agence Foncière Industrielle, AFI in French) to develop the new industrial zone (IZ) of Mlaâbi on a total area of 60 hectares. STEG and AFI concluded an agreement for the establishment of the Mlaâbi CS on a lot of 10 hectares in the IZ.

2.1.2 Equipment and buildings

The new Mlaâbi Converter Station will consist of a 600-MW AC-DC conversion module, connected on the DC side to the lines cable of the pole at ±500 kV and AC side to a newly built 400-kV kV OHVL.
The module will be operated at a nominal power of 600 MW in a monopole configuration and will consist of nr 2 bays for the 400-kV overhead line, for connecting the existing Mornaguia Electrical Station with the 400-kV busbar planned inside the Converter Station.
These bays will consist of vertical busbar disconnecting switches, circuit breakers, CTs, power line disconnecting switches with plates for earthing, VTs, arresters and air/cable terminals

- Nr 1 220-kV/400-kV single busbar system consisting of at least 4 busbar steps, busbar earth-connecting switches and busbar VTs
- Nr 1 line bay at 220 kV/400 kV, for connecting between the 220-kV/400-kV busbar planned inside the Converter Station with the conversion module: this bay will consist of vertical busbar disconnecting switches, circuit breakers, CTs, power line disconnecting switches with plates for earthing, VTs and with the addition of more VTs and CTs necessary for measurements and protections
- Nr 1 220-kV/400-kV busbar system consisting of:
    - Nr 3 bays with 220-kV/400-kV power supply of the respective three-cable filter banks in AC in turn derived from the line bay
    - Nr 5 220-kV/400-kV bays available
    - Nr 1 power supply bay for the converter transformers

  - Nr 3 three-cable AC filter banks, housed outdoors
  - Nr 1 bank with three single-phase transformers with two windings, kept outdoors (plus 1 spare machine serving the two poles)
- Nr 1 RI filter bank
- Nr 3 conversion reactors contained within a building (Reactor Building)
- Nr 1 converter with ± 500-kVdc voltage and 600-MW nominal power contained within a building (Valve Building)
- Nr 1 500-kVdc smoothing reactor and a set of direct current equipment required for connection between the module and the cable line at 500-kVdc pole, contained in a building (direct current building)

For the conversion module, the following will be installed:

- Nr 1 box for the generator set for emergency power supply of the Auxiliary Services
- Nr 2 MV/LV transformers for the safe power supply of Auxiliary Services
- Nr 7 kiosks

The CS area will also house various buildings:

- Reactor Building: contains structures and equipment making up the phase reactors. It will consist of a single floor building with a rectangular plan of approximately 50 m x 62 m and a height of 24 m.
- Valve Building: contains structures and equipment making up the power converters. It will consist of a single floor building with a rectangular plan of approximately 50 m x 70 m and a height of 24 m.
- Direct current (DC) building: adjacent to the valve building, it will house the 200-kV equipment. It will consist of a single floor building with a rectangular plan with dimensions of approximately 40 m x 55 m and a height of 24 m.
- Control Building: contains the auxiliary service equipment and the command-and-control equipment necessary to operate the converter substation. It will be divided into two floors with a rectangular plan of approximately 36 m x 30 m and a maximum total height of approximately 11 m. The ground floor will house the ventilation and air conditioning equipment, batteries and electrical distribution switchboards, DC and AC1 of ancillary services and maintenance equipment. The first floor will house the personnel rooms.
- Warehouse Building: it will consist of a single floor building with a rectangular plan of approximately 40 m x 20 m and a height of 12 m.
- Transformer fire extinguisher system building: it will house the pumping unit.
- MV and TLC delivery points building: contains the equipment necessary for the Medium-voltage power supply of auxiliary services and for the measurement and accounting systems; it will consist of a single floor building with a rectangular plan with dimensions of approximately 24 m x 3 m, and a height of approximately 3.20 m.
- Medium-voltage switching building: it will consist of a square-shaped building with dimensions of approximately 6 m x 5 m and a height of approximately 4 m.
- Kiosks for electrical equipment: intended to house the protection, command, and control switchboards; they will have a rectangular plan with external dimensions of 3 m x 5 m and a height from the ground of about 3 m.

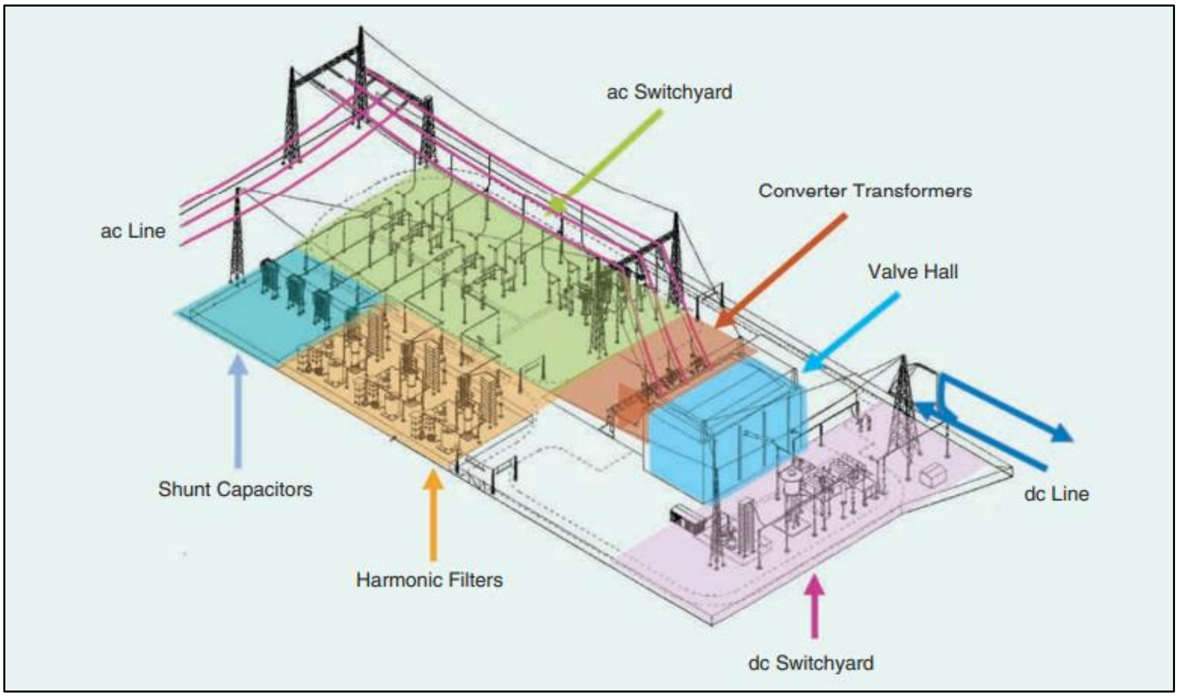


Figure 2.3: Example of a converter AC-DC station layout (source: IEEE Power & Energy Magazine)

2.2 Underground cable

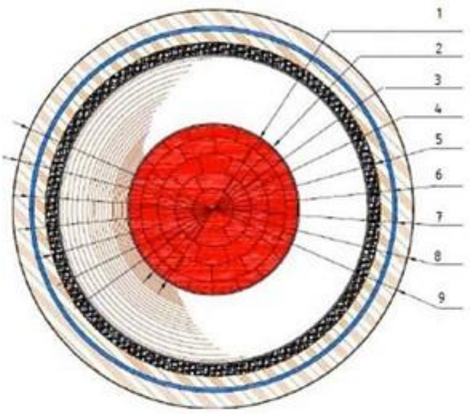
2.2.1 Route

An underground pole and an electrode cable will be laid to connect the new Converter Station of Mlaâbi and the landfall site of Kélibia, in the Municipality of Kélibia. The landfall site represents the connecting point, where a joint box will be installed to connect the undersea and the terrestrial cables.
The terrestrial cable will cross the city of Jameledine and will pass through existing roadways (the regional road that links Menzel Temime to Kélibia).
In order to avoid major interferences within the city of Menzel Temime (and thus to prevent potential impacts on the social environment), the route has been planned in order to make use of existing roads outside the urban area: more than 2/3 of the route is located on rural area (using existing agricultural roads with sufficient width to facilitate the transit of vehicles). The route is illustrated in the following figure.

Figure 2.4: Converter station area and HVDC terrestrial cable route

2.2.2 Technical characteristics of cables

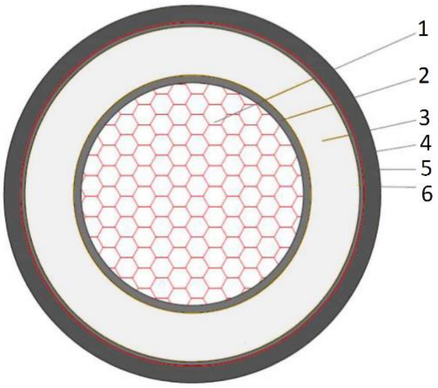
The underground power cable used may have impregnated-paper insulation (MIND) or cross-linked polyethylene insulation (XLPE). As an example, below is a standard cross-section of a MIND cable. The type of cable indicated is in any case only a guide and may change based on the technological choices made by the contractor.
The external diameter of the cable will be in the order of 110-120 mm, and the weight in the order of 30/40 kg/m.



Key	
1	Segmented copper conductor
2	Semiconductive layer
3	Insulation in layers of paper or paper and polypropylene impregnated with high-viscosity compound
4	Semiconductive layer
5	Lead alloy sheath
6	Polyethylene sheath
7	Galvanised steel tape reinforcement
8	Corrosion-proof polythene sheath

Figure 2.5: Characteristics of underground power cable

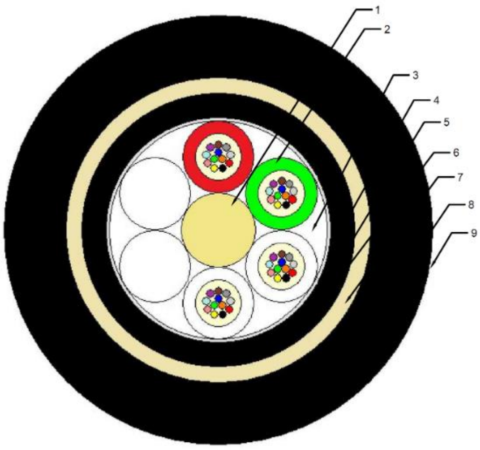
An electrode connection cable will be laid in the same trench with the DC pole cable: this cable will have the standard characteristics of medium-voltage cables.
The external diameter of the cable will be in the order of 55-70 mm, and the weight in the order of 6/8 kg/m.



Key	
1	Copper conductor
2	Semiconductive layer
3	XLPE insulation
4	Semiconductive layer
5	Metallic shield
6	External sheath

Figure 2.6: Typical cross section of electrode cable

An optical fiber telecommunications cable will be laid in the same trench of the power cable from the Partanna Converter Station to the landfall: the cable will have the scope of transmission of data for the protection, command and control system. A typical cross-section is presented in the following figure.
The external diameter of the cable will be in the order of 13 mm, and the weight in the order of 130 kg/km.



Key	
1	Central support
2	Loose tubes
3	Filling compound
4	Waterproof seal
5	Ripcord
6	Internal sheath
7	Non-metallic yarns
8	Ripcord
9	External sheath

Figure 2.7: Typical cross section of optical fiber cable

2.3 Mlaâbi to Mornaguia Overhead Line

The connection will begin at the 400 kV section of the new Mlaâbi Converter Station and end at the 400 kV section of the existing Mornaguia Electrical Station.
The consists of a double-circuit line on separate pylons with a length of approximately 113 km.
The overhead line (OHL) crosses areas belonging to:

- six delegations in the Nabeul governorate: Menzel Temime, El Mida, Korba, Menzel Bouzelfa, Beni Khalled and Grombalia;
- two delegations in the governorate of Ben Arous: Mornag and Mhamedia;
- one delegation in the governorate of Zaghouan: Bir Mchergua;
- one delegation in the governorate of Manouba: Mornaguia.

The information on the OHL line component is based on data provided by ELMED (the preliminary line route or corridor that will contain the double line) and on observations made by the Consultant during field surveys.

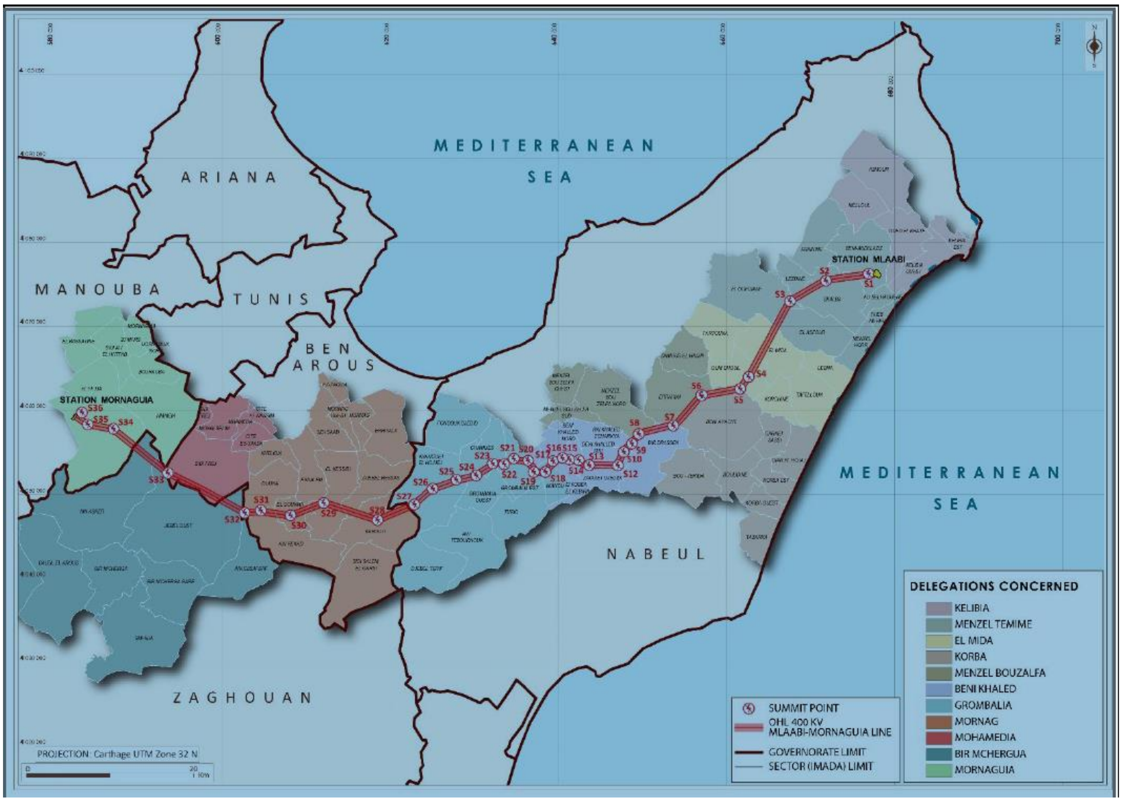


Figure 2.8: Route of the OHL and Administrative Units

2.3.1 Main components of the OHL line

Based on the data provided by ELMED and STEG, the OHL line of Mlaâbi will have the same characteristics of the Kondar-Skhira overhead line project.
An overview of the basic technical characteristics of the transmission line is presented in the following table.

Table 2-1: Overview of technical parameters of the 400 kV OHL Mlaâbi Mornaguia

Parameter	*Description*
Nominal voltage	400 kV (Highest voltage 420 kV)
Type of towers	Steel-lattice hot zinc-coated[1], single circuit self-supporting towers with horizontal configuration of conductors. Different types of towers will be used for the proposed line: - Type ''A2'' as an alignment support for low angle (< 2 degree); - Type ''B2'' used as a support angle when the angle is between 2° and 15° and anti-cascade; - Type ''C2'' when the angle is comprise between 15° and 30°; - Type ''D2'' used when the angle is between 30° and 60°; - Type ''E2'' used for angle comprise between 60° and 90° The final design of towers, by the contractor company, shall be compliant with specifications of the international standard IEC 60826.

[1] Two steel grades can be used (S355JO and S235JO according to EN 10025) with a good aptitude for hot-dip galvanization.

Parameter	***Description***
Foundation	Foundations will be defined by the contractor company in charge of the construction of the OHL line and based on the results of field surveys (soil and topography). Bases of foundation will be made of steel section with equal sides (as for the towers). Materials to be used : concrete type HRS 42,5, water (according to the requirements of NF EN 1008 standard), sand and gravel, concrete armature with steel bars (with a minimum elastic limit of 4200 kg/cm^2)
Conductor	Type AAAC 570 Minimal cross section: 570 mm^2 Maximum work stress (with a 20° temperature): 0.0585 Ω/km
Protective wire	A tubular cable containing optical fiber (around 48 fibers type G 652 D and type G 655 D) covered by aluminum steel wires and/or aluminum alloy wires. Dimension: ≥2.5 mm
Insulators	The conductor to be used for the present line double circuit will be equipped with composite as an insulator. The external insulation section is made of HTV (> à 50%) silicone.
Tower earthing	Type NFA 91 131 and/or NFEN 50189 Section: ≥43 mm^2
Insulator set fittings	Material: Steel hot zinc-coated. Dimension: Ø 8,4 ± 0,1 mm
Climate parameters	Wind pressure: average value 25 m/s / maximum 40 m/s External temperature: maximum 55° C/ minimum -5° C Moisture: up to 100 %

The main components of the OHL line are described hereafter.

2.3.1.1 Towers

Double circuit towers (pylons) will be used, directly built on site from a steel framework composed of individual structural sections.
For the proposed line between Mlaâbi and Mornaguia, several types of towers will be used, based on the result of the technical studies that will be conducted later by the contractor company in charge of the construction.
For overhead transmission line projects, several types of towers are used including the following:

- Suspension towers: they support the conductors/cables on straight stretches of line.
- Tension towers: generally used at points where the route changes directions.
- Terminal towers: used where the route terminates at converter stations.

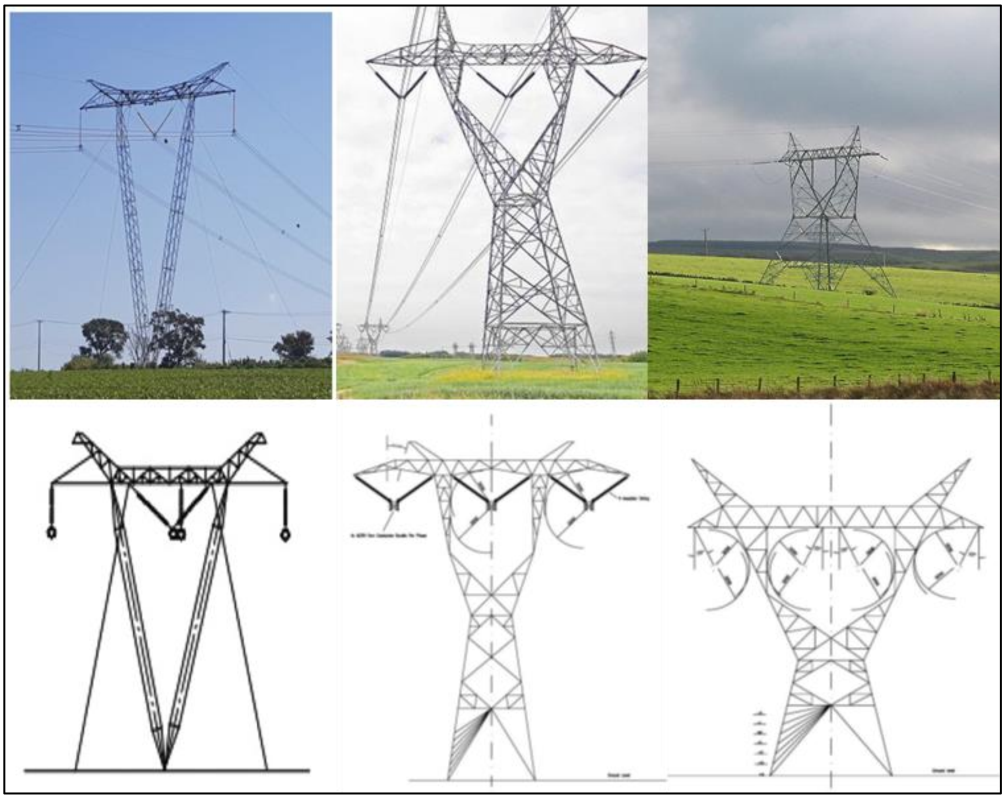


Figure 2.9: Typical of towers used on OHL projects (from left to right Suspension V tower - Self-supporting suspension tower - Self-supporting Y tower)

The towers will be steel lattice design and each tower will have four legs and single foundation per leg. The total number of towers and their exact location will be fixed just before the construction phase by the company in charge of the design of the OHL.

Typical footprint area that will be occupied by the four legs of the tower is expected to be around 200 m^2 (dimension of 14 m x 14 m).

The distance between towers will vary between 350 m and 600 m, depending on the conditions of the crossed area and its nature (soil, presence of wetlands etc.). The average length spans between two towers is around 450 m.

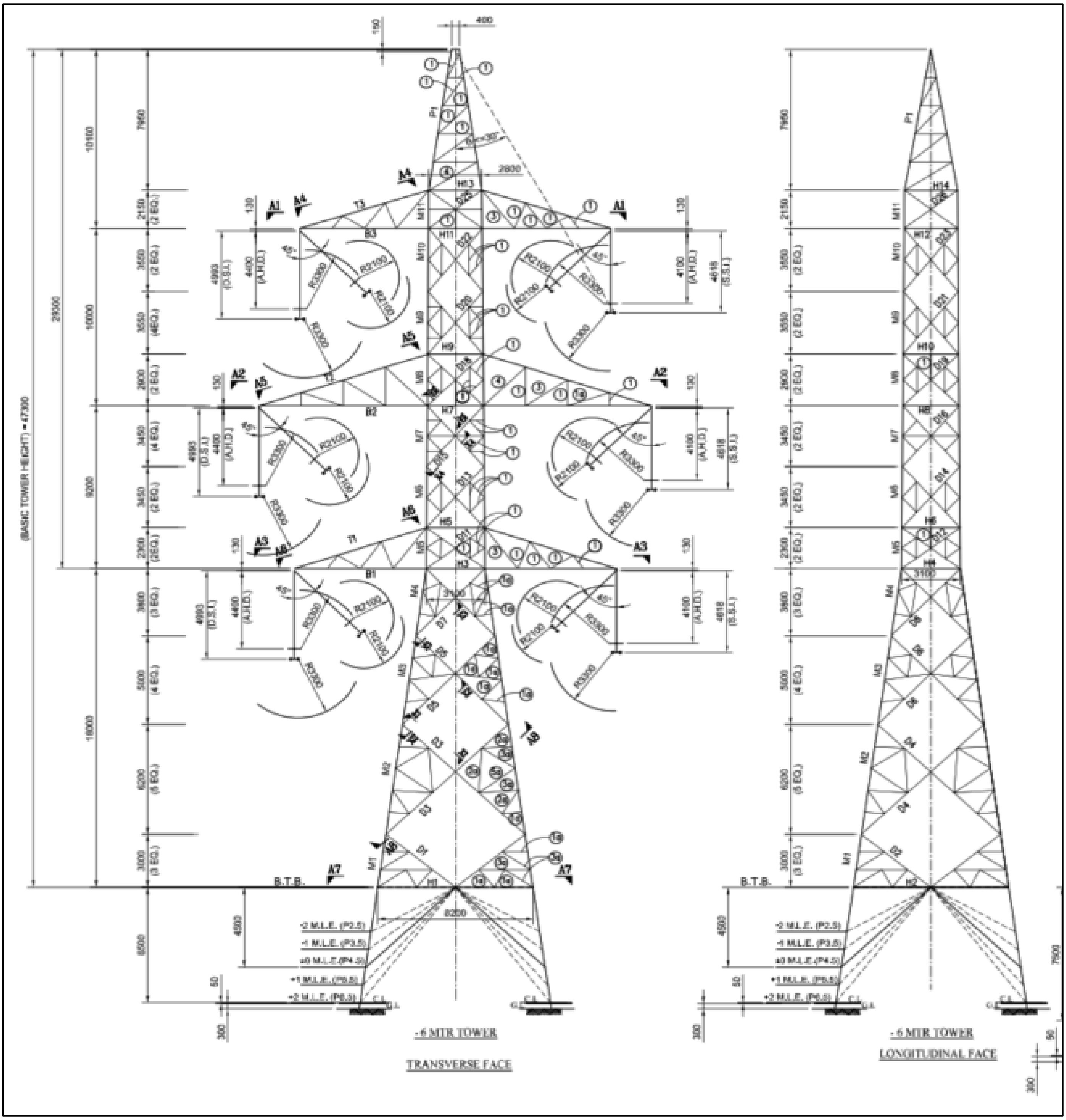


Figure 2.10: Typical of a double circuit 400 kV OHL tower (source STEG)

2.3.1.2 Foundations

The foundations of the towers will be built using reinforced concrete blocks (type HRS 42,5 generally used for STEG's power transmission lines). Based on the geo-technical investigation to be carried out later, a specific technical solution will be proposed for each tower.

2.3.1.3 Earthing

In order to reduce the effect of electric shock and to ensure safety at work, during both construction and operation phases, particular focus will be given to the tower earthing. All towers will be earthed using a 43 mm^2 steel cable connected to each tower leg through a ground block.

2.3.1.4 Conductor

The selection of the type of conductor to be used for OHL lines is based on three criteria: meet the requirement of current-carrying capacity and the requirement of electromagnetic environment, the good mechanical conditions and its cost.

The line conductors will be ALL Aluminum Alloy Conductor (AAAC) 570 type with normal cross section of 570 mm^2. The following figure shows a typical structure of an AAAC 570 conductor.

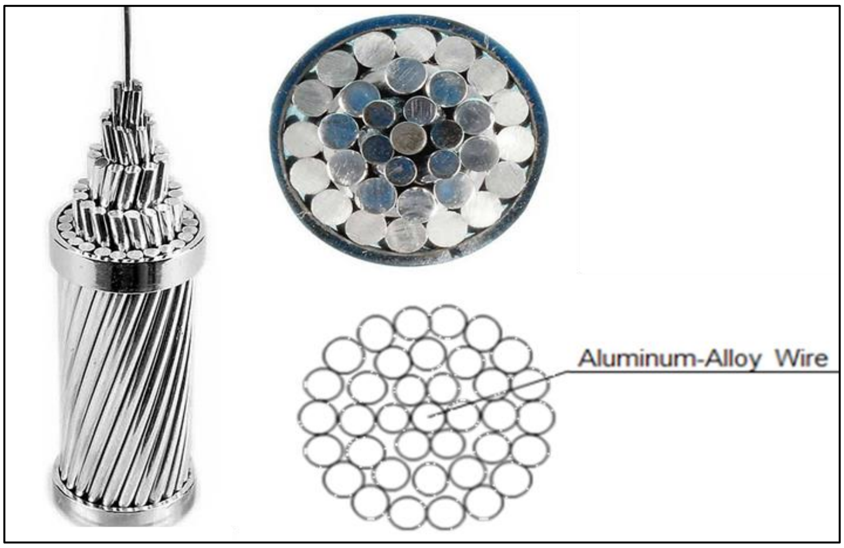


Figure 2.11: Typical structure of an AAAC 570 conductor (source HONGDA CABLE)

2.3.1.5 Insulators

The insulator to be used for the OHL shall be of composite type, as commonly employed by STEG for its power lines. The external coating of the insulator will be made of HTV silicone material.

Figure 2.12: Insulators for OHL (left: Toughened Glass type; right: Porcelain type)

2.3.2 Support components and activities

The implementation of the 400 kV OHL line will require a number of additional activities, which are necessary to facilitate the project's construction and other maintenance actions during operation phase. These include the following:

2.3.2.1 Clearance to ground and crossing

For the 400 kV OHL line, the suggested minimum clearances between the line corridor and houses and other facilities (roads, existing transmission lines, railway projects, telecommunication cables, etc.) and between conductors and other objects are presented in the following tables.

Table 2-2:Minimal distances between conductors and existing obstacles/facilities (STEG standards for OHL projects)

Receptor / description		**Minimum Height to be respected for 400 kV OHL**
Common land/proprieties		9 m
Paths accessible to traffic	Common road	10 m
	High traffic road	11 m
Other crossings	Plantations (olive tree, citrus orchards)	10 m
	Powered Railway lines	12 m
	Railways	20 m
	Telecommunication lines	6 m
	Power lines HTA	6 m
	Power lines HTB	7 m

The table below presents the minimum distances to be respected between conductors and existing residential buildings and other structures.

Table 2-3: Minimum clearance with residential building (source STEG)

Description	**Minimum clearance for 400 kV line**
From conductor location	16 m
From tower location	Tower height

For safety reasons project design should avoid placing towers near major and classified roads (national, regional, etc.). The following table shows clearance values, between tower's location and road axis, to be taking into consideration during the design of the line route.

Table 2-4: Minimum clearance between axes of roads and OHL towers (source STEG)

Description	**Clearance from tower (m)**
Agricultural roads	40
Classified roads (national and regional)	50
Highways	65
Intersections of roads	200

The conductor must be installed with a specific spacing, this clearance is calculated based on it median sag as indicated in the table below:

Table 2-5: Clearance values based on the sag of conductors (source STEG)

Description	**Clearance (m) for 400 kV**
Conductor sag between 0 and 20 m	7
Conductor sag between 20 and 30 m	8
Conductor sag between 30 and 40 m	8,75
Conductor sag between 40 and 50 m	9, 25

2.3.2.2 Establishment of right-of-way (RoW)

A land corridor will be fixed as a Right of Way for the proposed double circuit transmission line. The RoW is required in order to protect the equipment (avoid contact with trees to protect the system from any potential hazards as power failures or forest fires) and will include access roads to be used for construction and maintenance purposes.

The development of the OHL component does not include any major access roads.

3. DESCRIPTION OF TERRESTRIAL PROJECT: ASSOCIATED FACILITIES

All the works on the Italian side, described in this chapter, are considered as Associated Facilities.

3.1 Converter station

3.1.1 Location

The new converter station (CS) will be located in the municipality of Partanna (Trapani) in the area of "Contrada Staglio".
The total area occupied by the station will have a surface of 96,000 m^2 and is currently used for agriculture. Access will be guaranteed by a new access road.
The location of the new CS has been chosen based on a careful assessment of technical and environmental restrictions, in order to limit possible impacts and interferences with existing overhead lines.

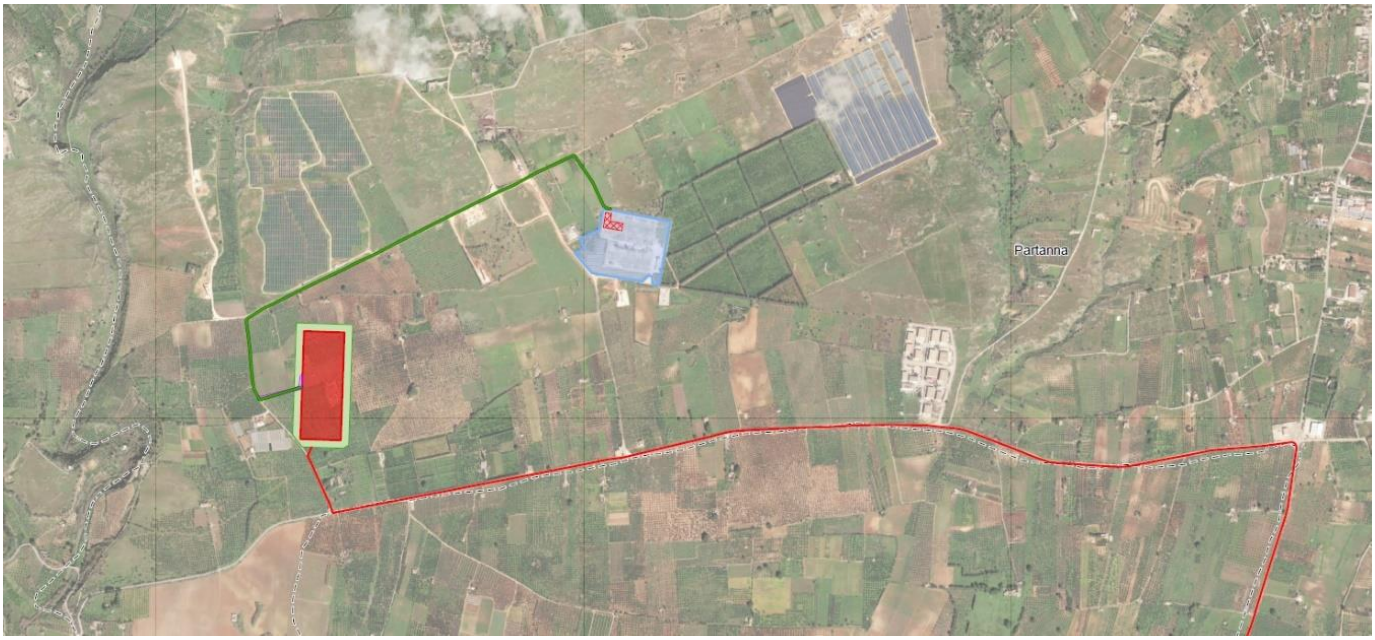


Figure 3.1: Converter station area and HVAC cable route

3.1.2 Equipment and buildings

The new Partanna Converter Station will consist of a 600-MW AC-DC conversion module, connected on the DC side to the lines cable of the pole at ±500 kV and AC side to the 220-kV section of the Partanna (TP) Electrical Station through nr 2 220-kV cables.

3.2 Works within the existing Partanna Electrical Station

For connecting the new CS to the National Transmission Grid (NTG), the following works will be required in the existing Partanna station:

- extending the 220-kV busbars (A in Figure 3.2) on the west side
- construction of a new line module, consisting of 2 busbar disconnecting switch, a circuit breaker, a set of three CTs, a power line disconnecting switch, a set of three arresters and a set of three air-cable terminals (B in Figure 3.2).

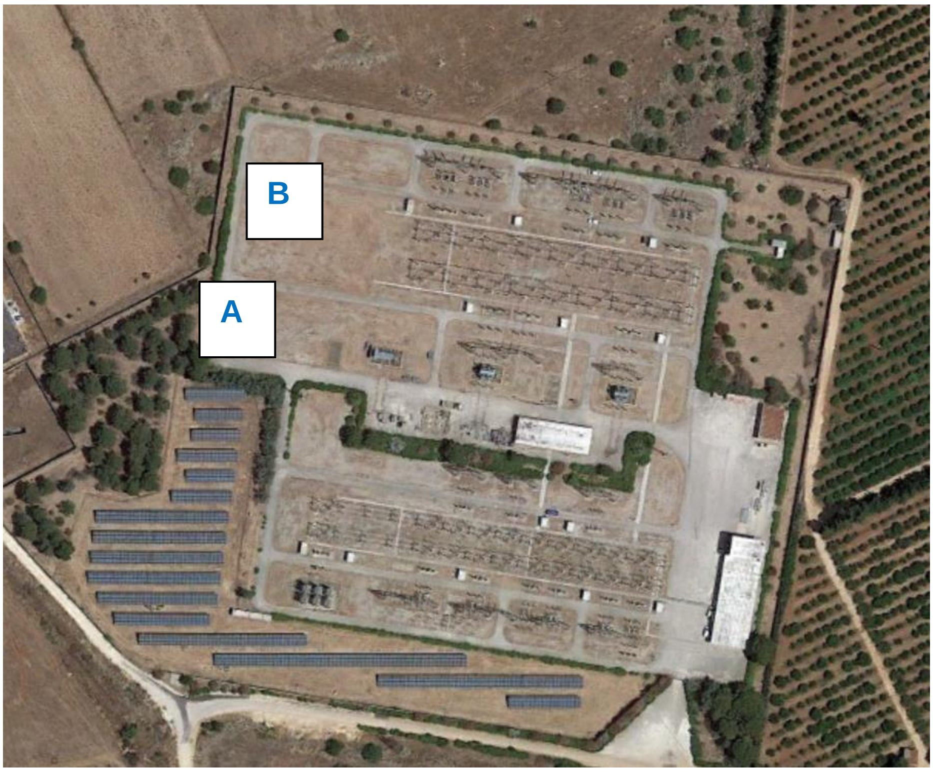
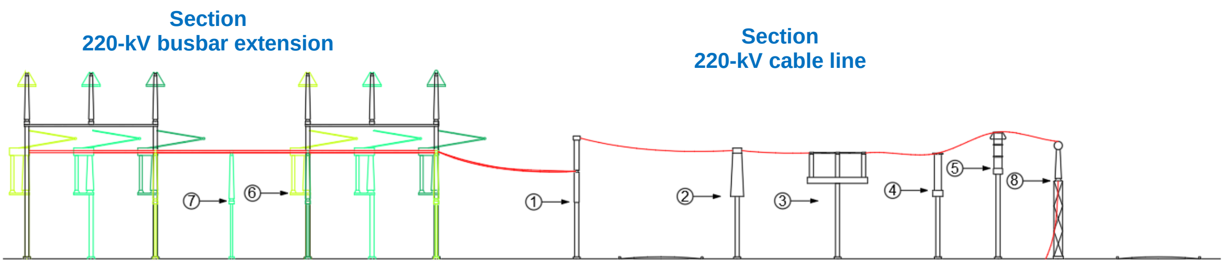


Figure 3.2: Works areas within Partanna Electrical Station



1		220 kV circuit breaker	
2		220 kV current transformer	
3		220-kV horizontal disconnecting switch with earth plates	
4		220 kV voltage transformer	
5		220 kV voltage transformer	
6		220-kV vertical disconnecting switch	
7		220-kV single-core support column	
8		220 kV cable terminals	

Figure 3.3: Cable line input section layout

3.3 Underground cable

3.3.1 Project Component B1

3.3.1.1 Route

The connection between the landfall point in Marinella di Selinunte and the Partanna Converter Station will be generated by an underground pole and electrode cable. The connection will have a total length of approximately 18 km.

The route of the cable has been planned in order to make use of existing roads; the route is illustrated in the following picture.

Figure 3.4: HVDC terrestrial cable route

3.3.2 Project Component D

The connection between the existing Partanna Electrical Station and the new Converter Station will consist of a 2 km 220 kV double-circuit underground cable: the route is shown in Figure 3.1.

The cables used for the line will have cross-linked polyethylene insulation (XLPE) or another insulating material and will be formed of a Milliken conductor in copper with internal sheath in soldered aluminum tube and external sheath in polythene.

4. DESCRIPTION OF MARINE PROJECT

4.1 Landfall

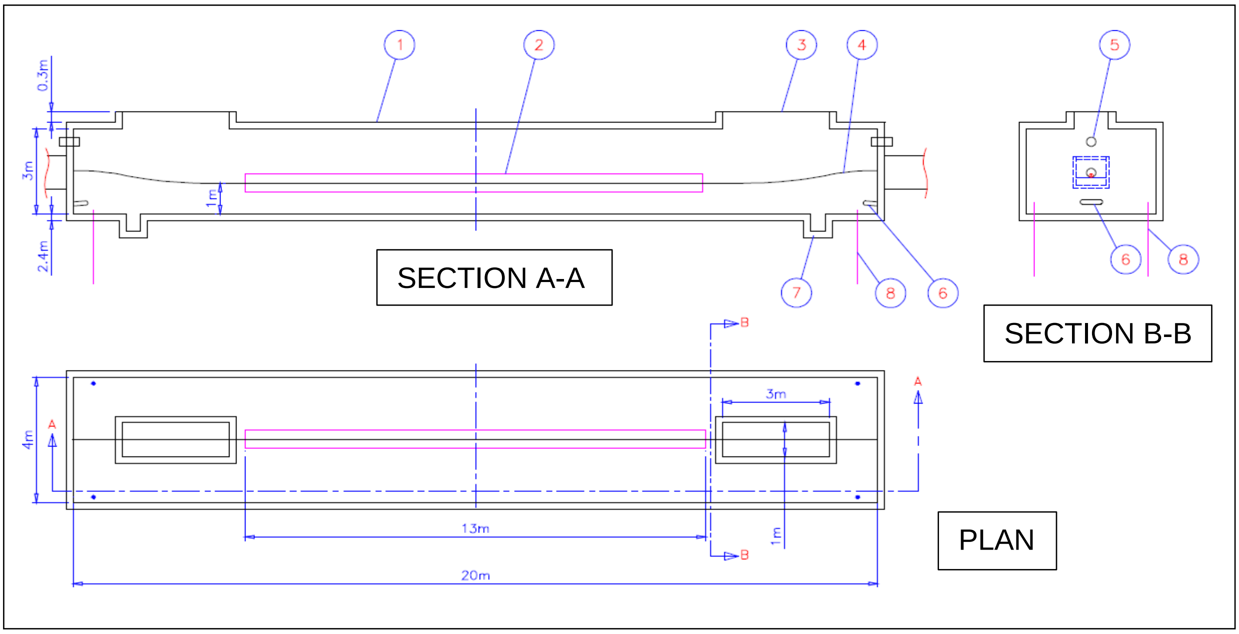
At the landfall sites, the transition of undersea cables to land will be engineered through the application of the Horizontal Directional Drilling (HDD) technique.
The landfall area for Tunisian side is shown in the following figures: the precise location of the landfall point will be defined during the executive design phase.

Figure 4.1: Aerial view of the landfall area in Kelibia

Figure 4-2: View of the landfall area in Kelibia

4.1.1 Land-sea joint boxes

The landfall will house underground joint boxes in which the undersea and underground cables will be connected (land-sea or L-S joints).
Separate joint boxes, with different dimensions, will house power, electrode and telecommunications (optical fiber) cables.



Key	
1	Joint box
2	Joint between underground and undersea cable
3	Inspection hatch
4	HVDC cable
5	Conduit for pulling line
6	U-shaped fixing bracket
7	Pit
8	Stakes of earth system

Figure 4.3: Typical of joint box for undersea/underground power cables

4.2 Power cable

4.2.1 Route

The undersea pole connection will link the two landing sites, one in Italy at Marinella di Selinunte, and the other in Tunisia at Kelibia. The length of the route is:

- approximately 100 km in Italian waters with a maximum bathymetric depth of approximately 160 m.
- approximately 100 km in Tunisian waters with a maximum depth of approximately 800 m.

Together with the pole cable, an undersea fibre-optic cable will also be laid, which will be used to enable operation and communications of the two converter stations.

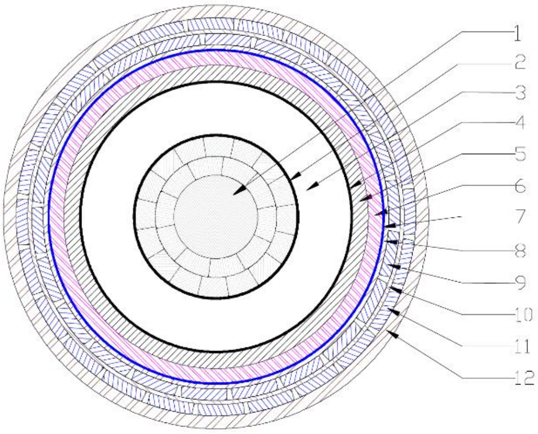
4.2.2 Technical characteristics of cables

The undersea pole cable will be of the impregnated-paper or XLPE type; in any case the cable will be insulated for 500 kV (reinforced insulation) and equipped with steel armor.

The following figure shows a standard cross-section of an undersea power cable with impregnated-paper insulation and in the table below, the main technical characteristics.

The type of cable indicated is in any case only a guide and may change based on the technological choices made by the contractor.

The external diameter of the cable will be in the order of 100-140 mm, and the weight in the order of 25/45 kg/m.



1	Segmented conductor
2	Semiconductive layer
3	Insulation in layers of paper impregnated with high-viscosity compound
4	Semiconductive layer
5	Lead alloy sheath
6	Protective thermoplastic sheath
7	Galvanised steel tape reinforcement
8	Synthetic tape padding
9	First layer of galvanised-steel armour
10	Polypropylene yarn padding
11	Second layer of galvanised-steel armour
12	External binding in polypropylene yarn

Figure 4.4: Typical cross-section of undersea power cable

An optical fiber telecommunications cable will be laid at the sea bottom close to the power cable: the cable will have the scope of transmission of data and communication. Mechanical protection of the cable is offered by double armor steel wire. A typical cross-section is presented in the following figure.
The external diameter of the cable will be in the order of 25-37 mm, and the weight in the order of 140-340 kg/km.

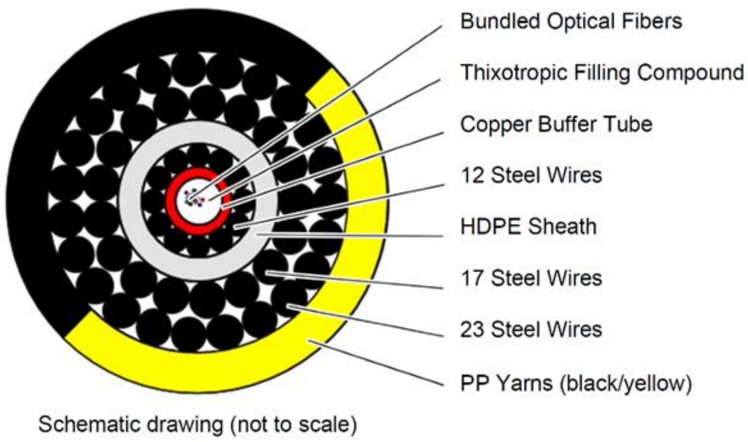


Figure 4.5: Typical cross-section of undersea optical-fiber cable

4.3 Electrodes

The electrode system is essential equipment for operation of an HVDC connection with monopolar configuration. It is made up of appropriate dispersers (sub-electrodes), each of which has individual elements of a sufficient number and size to guarantee dispersion of the rated current of the connection under system operating conditions.
A typical configuration for the undersea electrode is presented in the following figure.

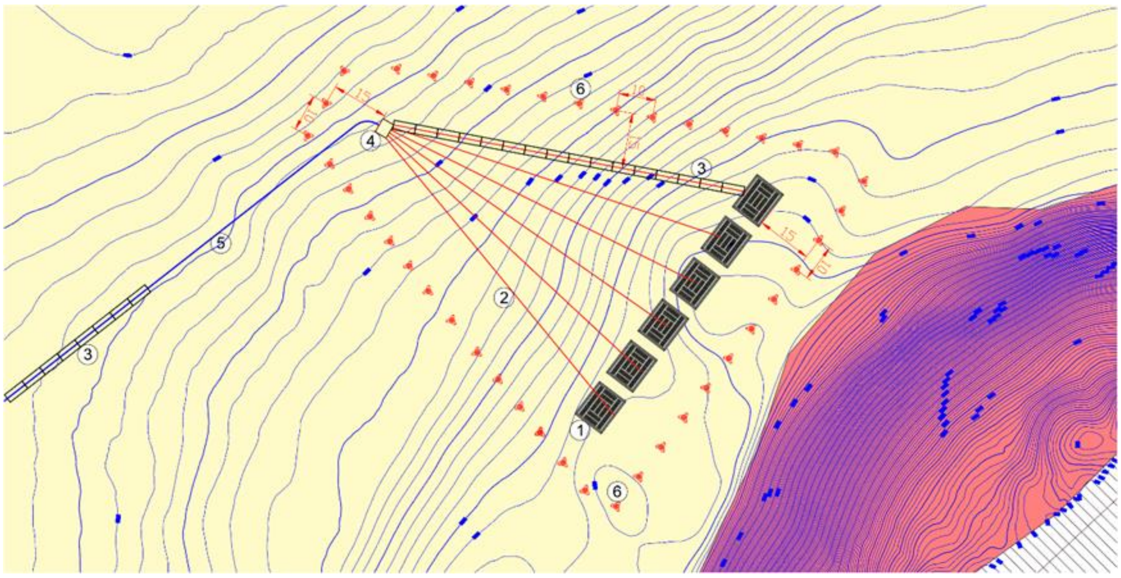


Figure 4.6: Typical layout of electrode system

In order to limit the risk of snagging by anchors or other fishing equipment (for example trawling equipment), the area around the electrode may be protected by a perimeter of deterrents of suitable size and shape, normally by cement tetrapod structures or similar.
The electrode, depending on the configuration (anode or cathode) will be connected to the seabed by special anchors.
Two possible design alternatives can be considered:

- Cathode: consisting of two raw copper elements with a suitable cross section connected to the undersea electrode cables using an insulated cord with joints at the ends and a total length of approximately 600 m;
- Anode: consisting of two sub-electrodes, each of which has an identical number of disperser modules (generally six) with dimensions of approximately 9 m x 12 m.

4.3.1 Tunisian side

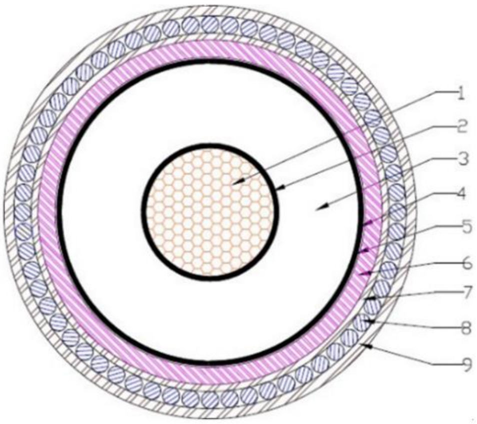
Undersea electrode cables, operating at medium voltage with extruded insulation, will start from the land-sea joint hole at the Kelibia landfall and will stretch out for approximately 9 km towards the marine area where the electrode will be installed in the sea. This area is planned south of the landfall and approximately 4.5 km from the coastline.
The electrode (cathode or alternatively anode) of the connection will be located on the seabed at a maximum depth of less than 40 meters approximately 4,5 km from the coast.

4.3.2 Italian side (associated facilities)

Undersea electrode cables, operating at medium voltage with extruded insulation, will start from the land-sea joint hole at the Marinella di Selinunte landfall and will stretch out for approximately 12 km to the south-west, towards the marine area where the electrode will be installed in the sea.
The electrode (cathode or alternatively anode) of the connection will be located on the seabed at a maximum depth of less than 38 meters approximately 6 km from the coast.

4.3.3 Technical characteristics of cables

The undersea electrode will be connected to the land by two undersea cables with extruded insulation (cables with rated voltage of 12/20 kV), with copper conductor.
Below are the main features of a typical cross-section for an undersea cable for connection to electrodes.
The external diameter of the cable will be in the order of 70-100 mm, and the weight in the order of 20/30 kg/m.



Key	
1	Round compact conductor in copper wire, buffered
2	Inner semi-conductive layer
3	XLPE or EPR insulation
4	Outer semi-conductive layer
5	Copper screen
6	Polyethylene sheath
7	Polypropylene yarn padding
8	Galvanised-steel-wire armour
9	External binding in polypropylene yarn

Figure 4.7: Typical cross-section of undersea electrode connection cable

5. DESCRIPTION OF THE CONSTRUCTION PHASE

5.1 Terrestrial project: description of construction works

5.1.1 Converter station

Works for building the new Converter Station will include:

- site preparation: fencing, preparation of access road, removal of vegetation and any existing structures;
- topsoil removal and installation of construction yard facilities;
- earthworks and area leveling;
- construction of foundations;
- construction of buildings;
- construction of firewalls;
- installation of machinery, electrical and electromechanical equipment;
- installation of prefabricated kiosks: these contain the peripheral switchboards for the auxiliary and command and control services of the bays;
- installation of prefabricated conduits and cable ducts;
- installation of electrical grounding system;
- water drainage systems;
- installation of utilities;
- road systems.

Figure 5.1: Single-core equipment foundations

Figure 5.2: Prefabricated kiosk

Figure 5.3: Firewalls – Shunt reactors

5.1.2 Underground cables

The installation of underground cables requires a sequence of operations which are described hereafter:

1. segregation of work areas with suitable fencing
2. preparation of the work area (removal of vegetation and surface obstacles)
3. investigations to verify the position of potentially interfering underground utilities
4. excavation of a trench
5. laying and installing the cable
6. filling the excavation up to ground level with suitable material
7. cable jointing
8. terminations
9. cable testing

The route is mainly located along existing roads: consequently trenches for cables will be dug preferably on road surfaces or otherwise at the border of the roads.
Trenches will have approximately the following dimensions:

- for DC cables: 0.70-0.80 m wide and 1.6 m deep;
- for AC cables: 1.60 m wide and 1.6 m deep, with concrete conduits.

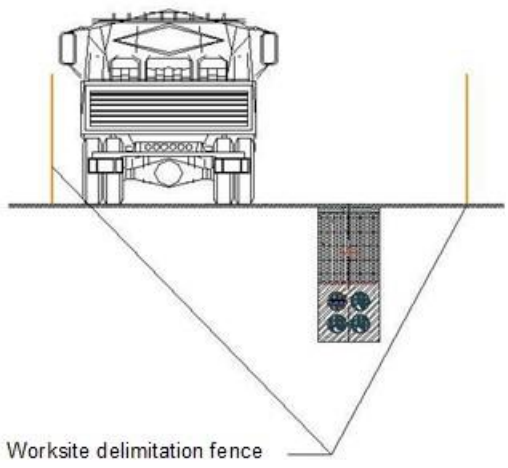


Figure 5.4: Worksite corridor for underground cables

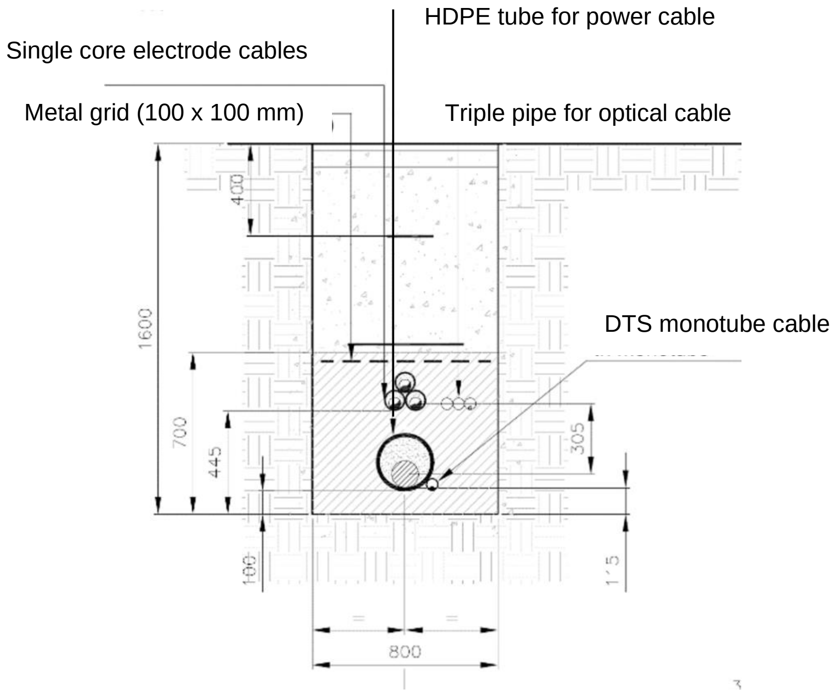


Figure 5.5: Typical of terrestrial cable laying on agricultural land

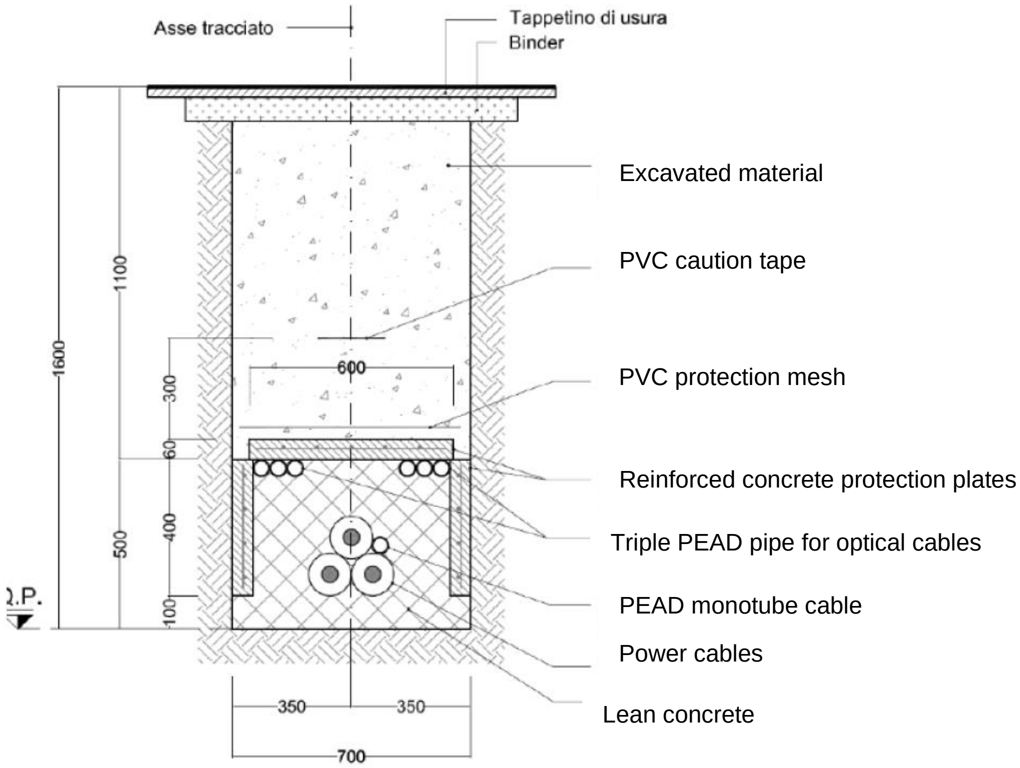


Figure 5.6: Typical of terrestrial cable laying on paved road

In highly urbanized areas cables are generally installed in PEAD (high density polyethylene) pipelines: this allows to restore the working areas in a shorter time, and therefore induce a shorter impact on the road. With this approach the only open excavations during the laying of a cable between two joint holes are the inspection holes for checking the passage of the cable during installation, which are usually placed in locations where there is a change in direction of the route.
Excavated material must be stored in a temporary storage area close to the worksite; excess material should be disposed.

Figure 5.7: Example of cable installation on a paved road

After excavating the trench, the cable is installed. The cable is laid for the entire length of each section of the worksite comprised between two consecutive joint holes (usually from 500 to 800 m), according to the following procedure:

- positioning of the winch and of the reel containing the cable at the two extremities of the section;

- positioning of metal rollers in the trench to reduce friction during cable pulling;
- installing a steel pulling cable that connects the pulling winch to the head of the cable in the reel;
- installing the cable through the recovery of the pulling rope by the pulling winch.

Activities are constantly looked after by personnel located along the entire route and especially at critical points (bends, underpasses, pipelines etc.). The operation is repeated for the power cable, the electrode cable, the equipotentiality copper cables and the optical-fiber cables.

Typically, the width of the worksite is around 4 m; larger areas may be required at the extremes of the worksite where joint pits are planned.

Figure 5.8: Example of cable laying in a trench

In the case of open-pit installation, the cables laid inside the trench are covered by a layer of about 50 cm of cement mortar. The cables will be mechanically protected by reinforced concrete plates showing the tension level of the cable duct arranged on the sides and on the top of the duct. An orange safety barrier will then be placed on this screen.
The remaining portion of the trench will be filled with excavated material or other suitable material; in the middle of this filling, additional caution tape will be put in place. Finally, the excavation trench will be definitively closed, in case of installing on roads, with resurfacing of the pavement.

Figure 5.9: Backfilling with installation of protection plates and PVC mesh

In case of cable pipeline installation, the trench will be generally filled with the excavated material. The trench will be closed (in case of installing on roads) with a layer of binder and, following the natural settling of the materials used for filling the trench, the pavement will be eventually restored.

Figure 5.10: Power cable installation in HDPE pipeline

If along the route waterways are encountered, they will be under-crossed so to avoid any hydraulic risk. Adequate protection works will be designed in order to prevent any risk of erosion.
For major interferences HDD technique will be applied.

5.1.3 Over Head Line

The land requirement for the OHL line includes the following aspects:

- development of access roads, which will be used both for construction and maintenance activities;
- installation of construction camps for workers and storage sites for equipment and materials;
- exploitation of borrow pits to provide aggregates.

The construction of the line will require a series of activities:

- detailed topographical survey;
- detailed geological survey with on-site and laboratory soil investigations (to verify the soil compatibility for foundations),
- definition of the route and of the towers' location;
- foundation and structural design;
- site preparation;
- construction of towers' reinforced concrete foundations;
- installation of conductors;
- wire tensioning and fastening.

The entire route of the transmission line is accessible through the major regional roads and other agricultural roads. The construction contractor will use existing roads to reach the tower worksites: only if access is not available, a new access road will be prepared.

5.1.4 Construction yards and transportation

A series of construction yards will be installed for the works:

- a major construction yard in an area close to the perimeter of the CS;
- a smaller worksite (approximately 1200 m^2) at the landfall site;
- a series of small storage areas along the route of the underground cable and of the OHL.

All materials for construction will be transported to the worksites by truck.
Traffic induces by works will be:

- For underground cables and the OHL in the order of 5-10 trucks/day;
- For converter station in average in the order of 10-20 trucks/day.

Personnel employed in the worksites will be transported by car or van.

5.2 Marine project: description of construction works

5.2.1 Horizontal Directional Drilling

The HDD (Horizontal Directional Drilling) technique involves drilling straight holes of appropriate length and depth so that they are not subject to problems of "uncovering" of the system due to coastal erosion.
During the drilling operations, plastic tubes are installed, with an internal pulling line that will serve, during installation of the undersea cable, to slide the head along the inside of the pipe.
This method will be applied at landfall sites: in particular 3 drillings will be executed, one for each cable: electrode cable, DC power cable and fiber-optic cable.
In general, the angles of entry and exit for drilling depend on: morphology, obstacles to avoid, ground properties, diameter and rigidity of the tubes to install.

Considering the technology currently used for similar applications, and the limits imposed by soil properties, HDD may be used:

- on stretches generally no longer than 600–800 m in plan
- with depths of the exit hole under the sea level below 30 m, considering the need for support from Technical Divers for cable pulling operations;
- with drilling from land towards the sea.

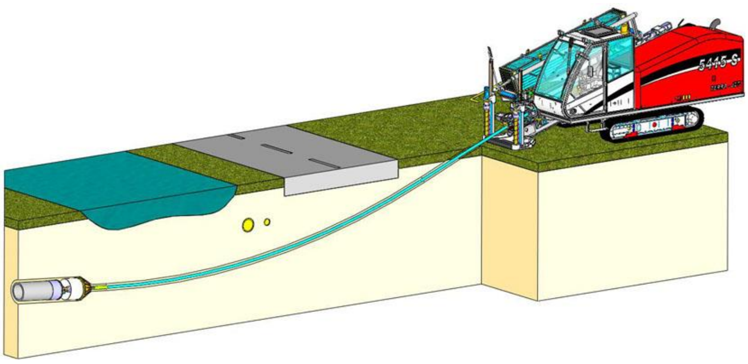


Figure 5.11: HDD technique

Figure 5.12: HDD machinery

Drilling machines consist of a tracked vehicle (drilling unit) with a drilling tower (mobile element that can be tilted, which carries out the different drilling phases).

Drilling with this technology is carried out in sequence with the following phases:

- drilling of pilot hole
- reaming
- installation of conduit.

The drilling machine is positioned and aligned along the drilling axis and, once a suitable starting angle has been set, the drilling head is rotated on a rod to create the pilot hole. Inside the drilling head, which has a symmetrical bit profile, there is a probe with transmitter which sends signals directly to the surface by using magnetic waves. At the end of the drilling head there is a jet sprayer that is essentially formed by a rod with a longitudinal angled piece with holes (nozzles) for injection of fluids (biodegradable drilling mud), which are pumped into the ground at high pressure, enabling cutting and stabilization of the hole, holding it open and reducing friction.
The progress of the drilling head through the ground occurs due to the combination of it being driven forward and its rotation, powered by the machine and due to the effect of the jet of biodegradable mud. The straight progress by drilling (rotation and driving forward of the rods) can be adjusted by positioning the bit on the drilling head in a specific direction, according to the desired axis, simply by pushing the rods.
Once the pilot hole has been generated, the drilling head is removed from the guide pipe and replaced with a reamer, which is used to widen the hole and stabilize it through the use of biodegradable drilling mud. This operation is carried out in the opposite direction to the pilot hole: in fact, the reamer is pulled again by drilling (rotation and pull) from the exit point to the point where drilling began. As the exit point of the drilling is in the sea, a small marine worksite will be needed, typically composed of a barge equipped with lifting equipment to provide assistance and a service vessel for transfers and transport. The diameter of the reamer and the number of cycles to carry out depend on the nature of soil, the diameter of the conduit to be installed and the power of the machinery. In fact, based on the aforementioned characteristics, it is possible to proceed with reaming simultaneously with pulling of the conduit, rather than through continuous repetition of reaming, changing the reamer (pre-reaming) and gradually widening the diameter of the hole working backwards with subsequent cycles using reamers of increasing diameter and exploiting the capability of the jet of biodegradable mud to remove the excavated material.

On land, the columns of the pulling conduit will be welded and, after the final reaming cycle, the conduit will be transported offshore and then installed by pulling, using the rods and drilling head, through the previously reamed hole. Pulling is usually carried out from sea towards land.
During laying of conduits it is standard practice to use biodegradable drilling mud, which in addition to stabilizing the walls of the hole also lubricates conduits and facilitates the laying process, reducing friction between the conduit and the soil.

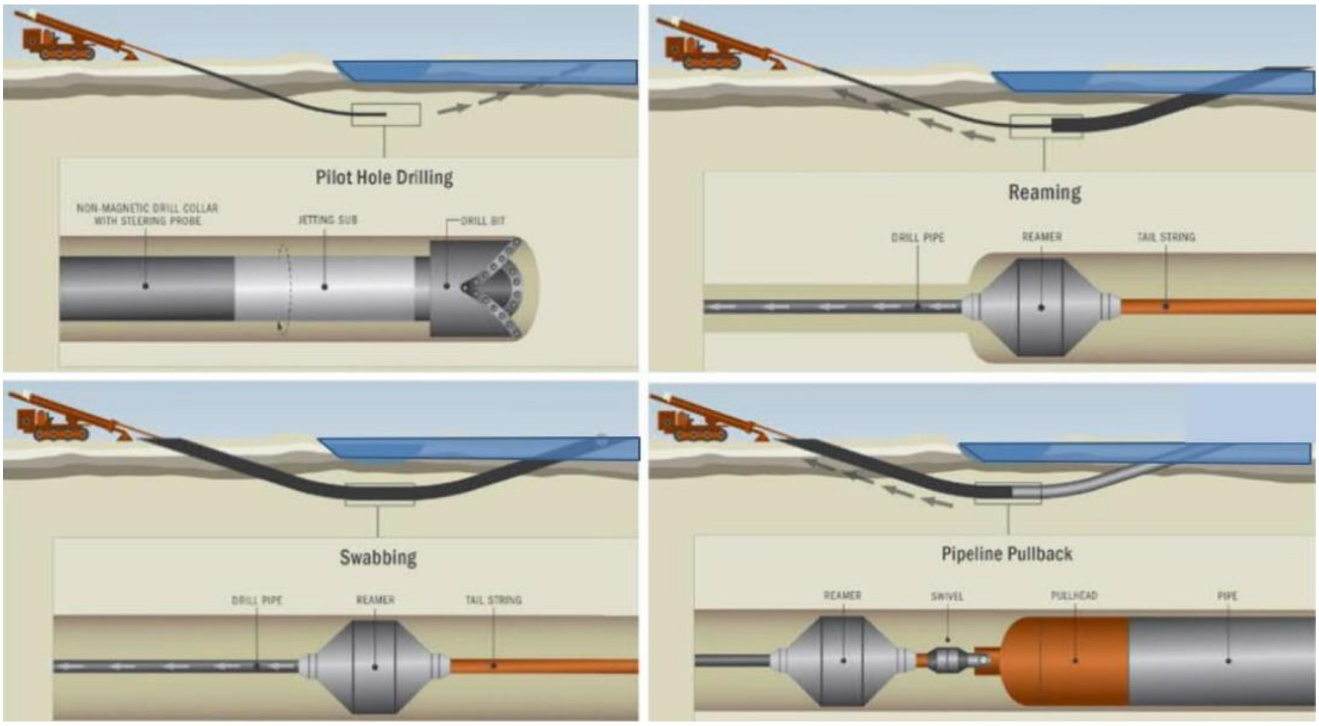


Figure 5.13: Diagram of drilling operations

Precise knowledge of the position and direction of the drilling head under the ground is essential in order to follow the planned route and to carry out corrections and changes in drilling direction. This information is gathered from a probe located inside the pilot rod, near the drilling head: this probe, which can detect its orientation in relation to the Earth's magnetic field, provides details of the inclination and azimuth of the drilling head.

These values, together with the distance drilled, are received, and translated into data required for the correct execution of drilling, enabling calculation of the horizontal and vertical coordinates along the pilot hole. The use of continuous transmission systems enables instant detection of the position of the probe (depth, direction, inclination of the head, etc.), allowing corrections.

The area occupied by the worksite for operations on land will cover approximately 1200 m^2, organized as shown in the following figure.

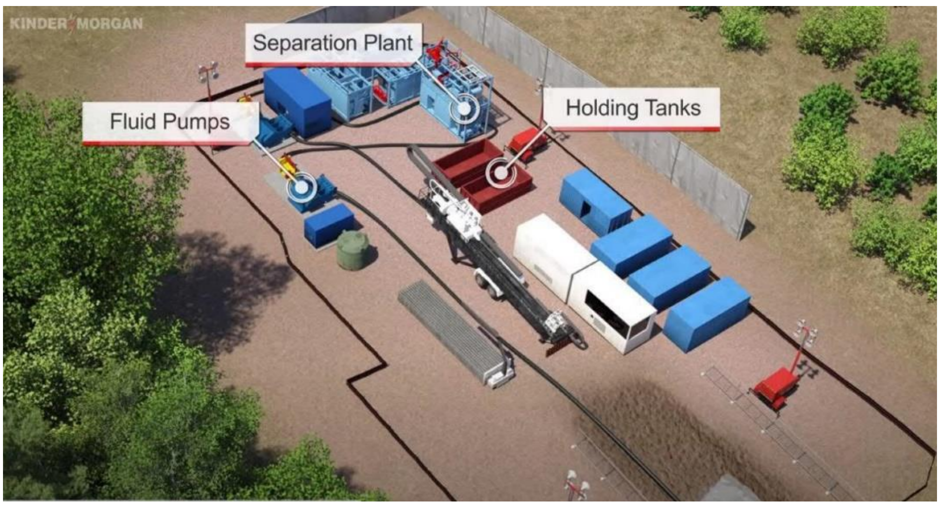


Figure 5.14: Example of HDD worksite and equipment

5.2.2 Laying of undersea cables

Laying of undersea cables is carried out by a special cable-laying ship: using a winch, the reel of the cable is unwound, and the cable is laid across the seabed.
Examples of cable-laying vessels are shown in the following figures.
Cable laying works are a 24 hours / 7 days activity.
Before the laying process, the route is cleared using a grapnel to remove any potential obstacles. In sensible areas this operation will be carried out by underwater technical operators.

Figure 5.15: Cable laying vessel Nexans Skagerrak

Figure 5.16: Cable laying vessel Giulio Verne

For installation at the landfall sites, the procedure indicated in the following figures will be applied, involving the use of service boats to assist the main vessel when pulling the cable heads to land, held at the surface by floats during work, and the pulling of the cables from sea towards land in the conduits previously installed using the HDD technique.

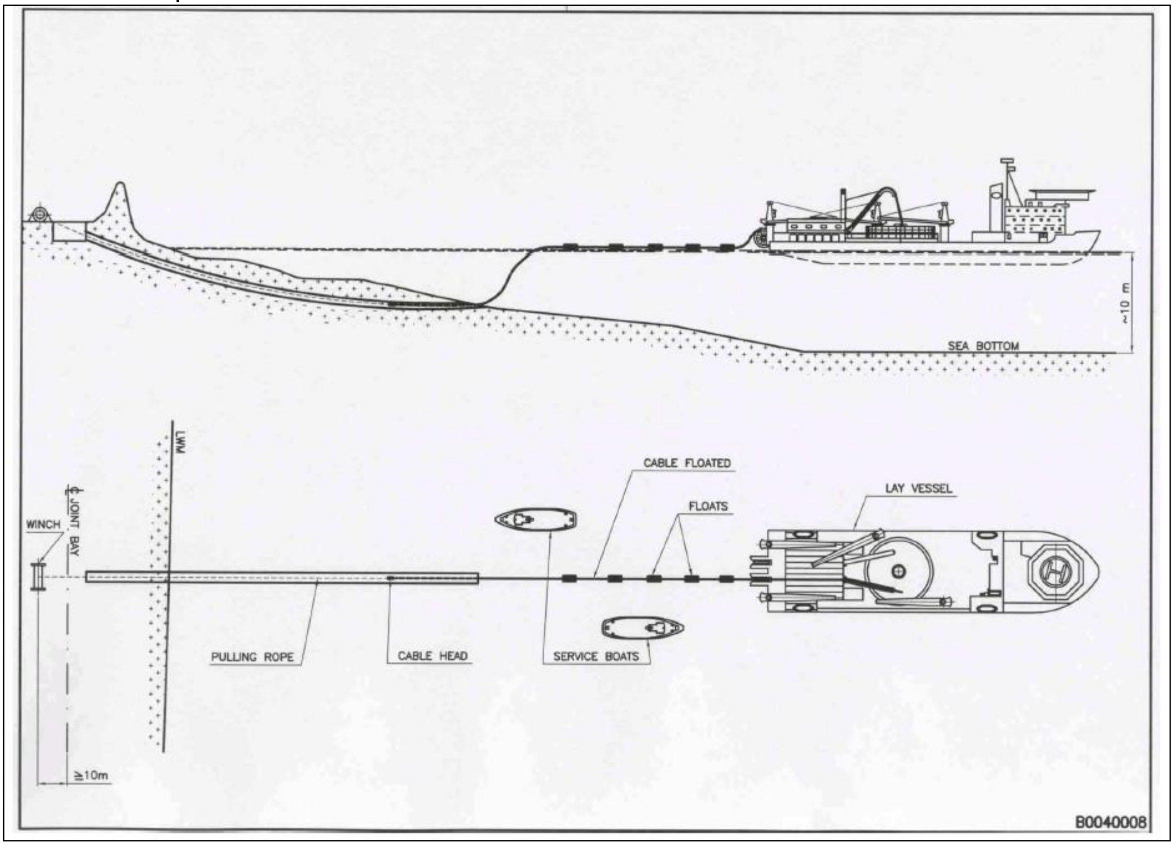


Figure 5.17: Typical pulling of undersea cable from land using conduits installed with HDD technique

5.2.3 Protection of undersea cables

Cable burying is required for safeguarding a strategic infrastructure belonging to the National Electricity Transmission Grid. Intensive human activity (fishing) is recently increased also in areas colonized by marine biocenoses and represents a significant risk of damage for undersea cables, with potentially dramatic consequences for the electrical connections.
Outages, in addition to being extremely costly for the electricity system, require maintenance and repair activity for the creation of joints in the damaged cable, thus creating disturbance, although limited, to the marine environment. Once a fault has been identified, maintenance activities require to hook the cable from the seabed, lift it up onto the ship used for the work, create the joint on board and then reinstall the cable with the same methods normally used for installation and protection.
Cable protection is therefore an essential measure and even more so in the presence of important biocenoses such as *Posidonia oceanica* meadows, as these areas are experiencing great pressure from human activities, in particular illegal bottom trawling.
Cable burying can reduce the occurrence of faults due to human activity and thus need for repair work: so it also acts as a protective measure for the biocenoses, which will be affected only once by operations for installation and protection of the cable.

The following figure shows various images of damage generated by human activity on unprotected undersea cables.

Figure 5.18: Unprotected undersea cables damaged by human activity

The technologies that will be applied for cable protection are illustrated in the following paragraphs: the choice will depend on seabed soil characteristics and will therefore be defined directly by the Contractor during the final planning phase.

5.2.3.1 Jetting

The jetting technology involves protection of cables by burying them with sand using a machine that sprays jets of water; this technology can be applied where the seabed is made of uncoherent sediments, e.g., sand, clay, or loam. Generally, the machine uses the water jets also for propulsion. Where it is not possible to propel the machine using hydraulic means, self-propelling jetting machines with tracks and/or a ROV can be used.

Figure 5.19: Self-propelled jetting machine

Figure 5.20: Tracked jetting machine

For generating the trench, the machine is positioned over the cable to be buried: the action of high-pressure jets of water liquefies the soil, creating a trench into which the cable settles and is then naturally covered by deposition of the suspended sediments within the trench. Currents action on the seabed contribute to completing the process of naturally burial of the cable, guaranteeing its effective protection.
In standard conditions the base width of the trench is approximately equal to the diameter of the cable (15–20 cm), whereas the top width depends on the friction angle and the cohesion of the displaced sediments.

At shallow depths protection operations may be carried out manually by Technical Divers with the same effects above described in terms of width of the trench and volume of material displaced.
For uncoherent seabed sediments colonized by important biocenoses (e.g., *Posidonia oceanica* or *Cymodocea nodosa*), it is possible to use machinery for jetting that, in addition to being maneuvered directly by technical divers, is connected to a floating system so to reduce the impact to the sole width of the trench (30–40 cm). This type of machinery basically has no lateral footprint and allows for a minimum impact on the area around the work.

Figure 5.21: Machinery for jetting over Posidonia oceanica on sand sediments

In case of trenches to be excavated in areas with significant biocenoses, such as *Posidonia oceanica* or *Cymodocea nodosa*, filling of the trench is normally carried out by backfilling, i.e. with the same material excavated, by promoting natural closing of the trench.

Figure 5.22: Trench over Posidonia on sand generated with a jetting machine

The following table illustrates the main characteristics of the jetting technique.

Table 5.1: Overview of the main characteristics of the jetting technique

Type of seabed	Low level of cohesion (sand, clay, or loam)
Burial depth	Up to 1–2 m
Average trench width	0.3–0.4 m
Width of machine footprint	Maximum 3–4 m with use of tracked machinery
Excavation method	Jets of sea water
Propulsion	Jets of sea water, towed by boat, tracked
Use of additives	None. Only sea water is used for excavation

5.2.3.2 Trenching

Trenching technique is used with cohesive or cemented sediments. The trench is dug using a machine equipped with a disc tool or a toothed chain. The material removed during cutting is laid at the border of the trench: backfilling occurs as a natural process due to the action of bottom currents.

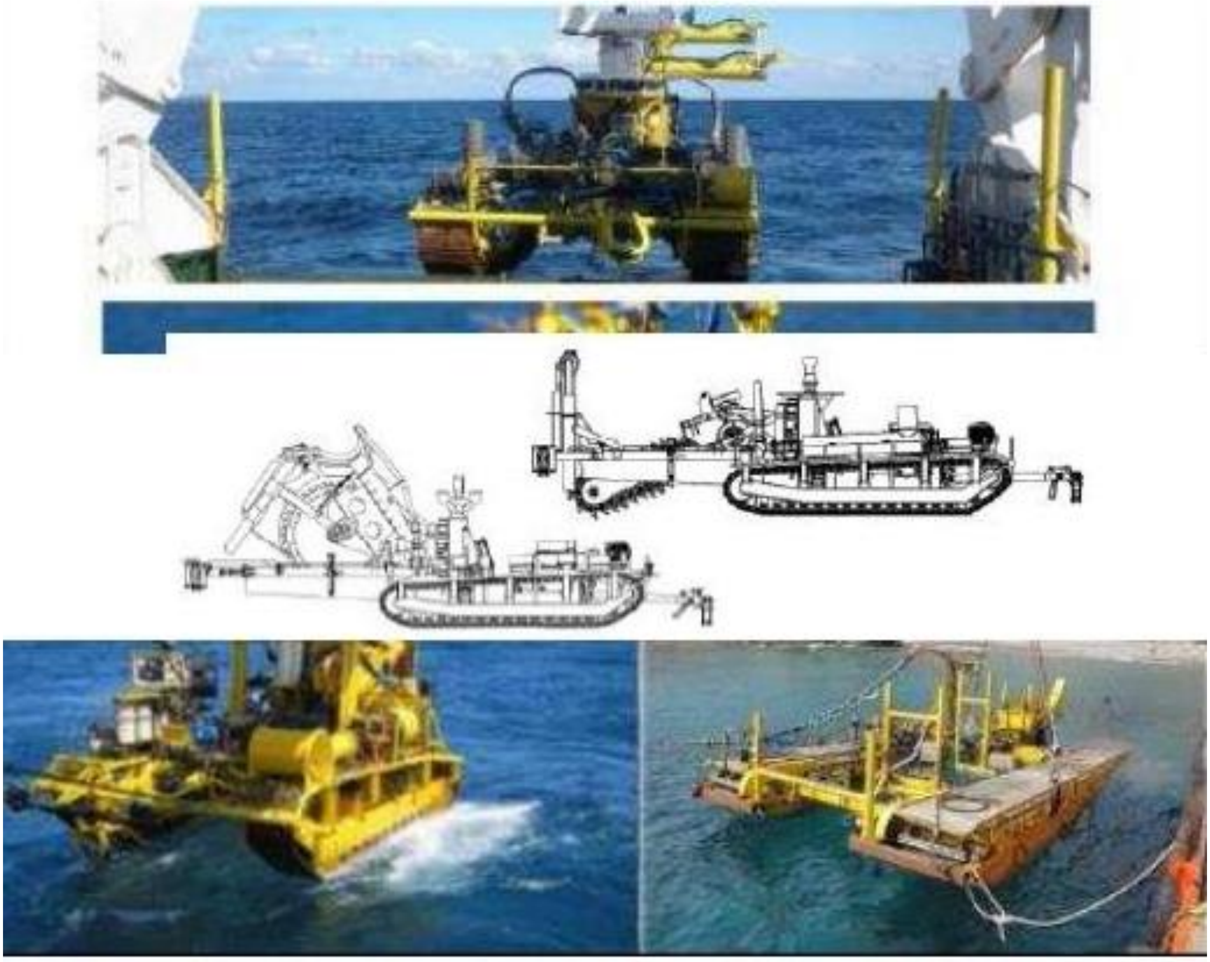


Figure 5.23: Conventional trenching machine

Figure 5.24: Cutting tool for trenching machine

The depth of the trench depends on protection requirements and on soil seabed mechanical properties. The following table illustrates the main characteristics of the technique.

Table 5.2: Overview of the main characteristics of the trenching technique

Type of seabed	Varying level of cohesion (over consolidated, cemented and Posidonia matte)
Burial depth	Up to a depth of 2 m
Average trench width	0.2–0.5 m
Width of machine footprint	Maximum 3–4 m with use of tracked machinery
Excavation method	Mechanical
Use of additives	None. Only sea water is used for excavation

Where sensitive habitats are interfered trench filling (in proper technical and environmental conditions) can be carried out using materials suitable for recolonization by phanerogams, such as sandbags or rock dumping. This allows both to restore the seabed vegetation and to increase cable protection.
Another technique for minimizing impact on phanerogams consists in the use of controlled floating trenching machinery, that allows to reduce the footprint on the seabed to the actual width of the trench.

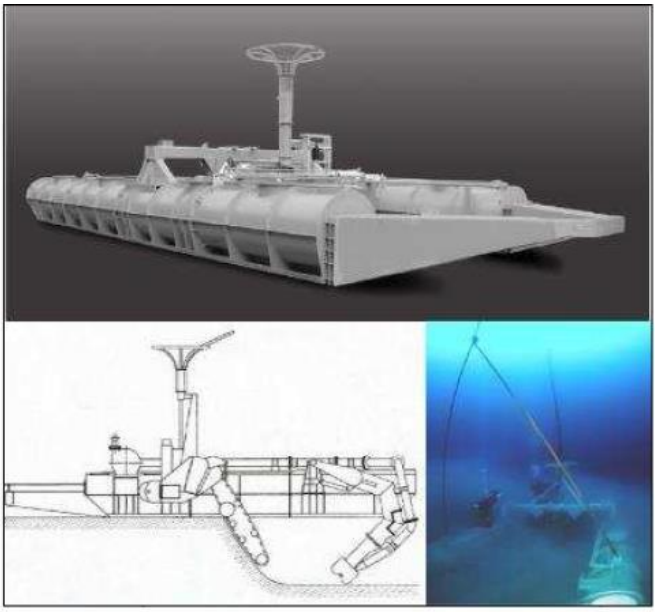


Figure 5.25: Example of controlled floating trenching machine

Controlled floating trenching machinery is specifically designed for the creation of trenches for the protection of undersea cables and pipelines where the presence of *Posidonia oceanica* or *Cymodocea* or other protected species requires use of non-invasive excavation methods. The cutting tool is installed on a controlled floating structure capable of minimizing the weight and therefore the impact on the meadows. The unit is generally formed by a catamaran structure with two parallel cylinders of 1 m diameter that support the device for cutting and excavation, as well as mobility systems.
The machine is directly managed by divers. The cutting system may be combined with a dredging pump if it is necessary to maintain the trench free of debris.
Since the machine is adjustable in terms of weight and therefore friction against the seabed, it is possible to ensure that the pressure on the leaves of the phanerogams is practically zero as sliding of the runners is facilitated by the leaves of the plants without any damage to them. The resulting trench, given the compact nature of the surface of the matte and the level of cohesion of the sediments, has a width only slightly greater than the diameter of the cable.

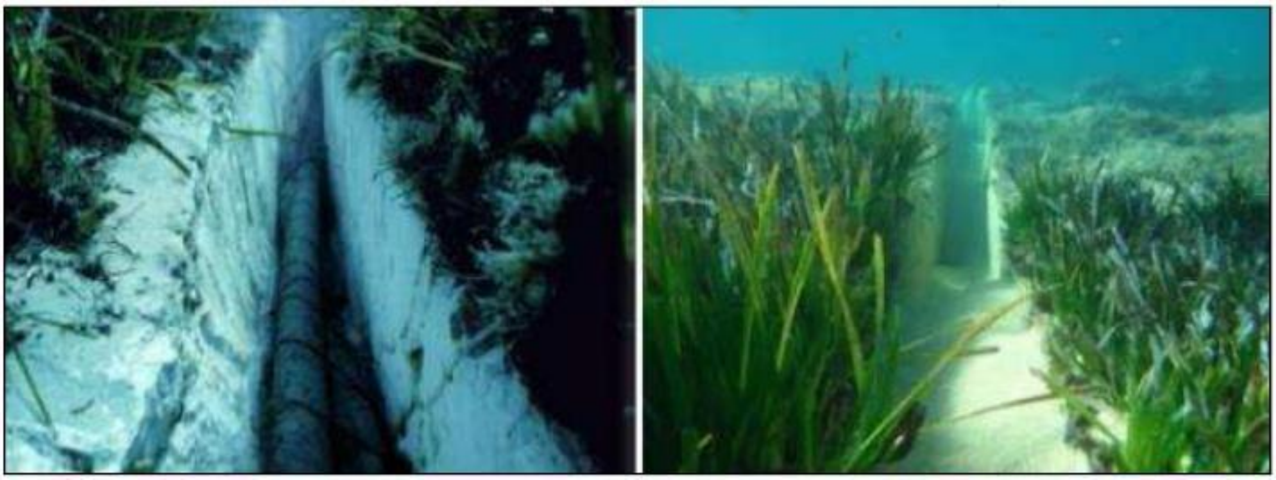


Figure 5.26: Trench over Posidonia generated with controlled floating trenching machinery

5.2.3.3 Rock dumping

Where characteristics of seabed or of sediments do not allow using one of the previously illustrated protection methods, the undersea cable will be simply laid on the seabed and then protected by covering with fine, mixed gravel mechanically deposited by a ship. The geometry of the protection system is shown in the following figure.

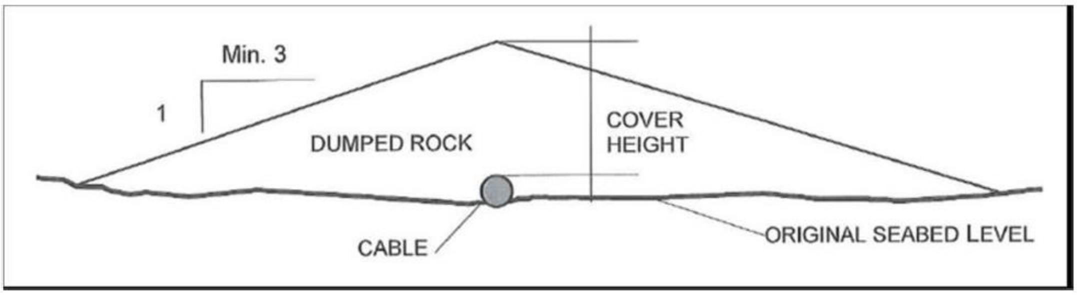


Figure 5.27: Typical of rock-dumping geometry

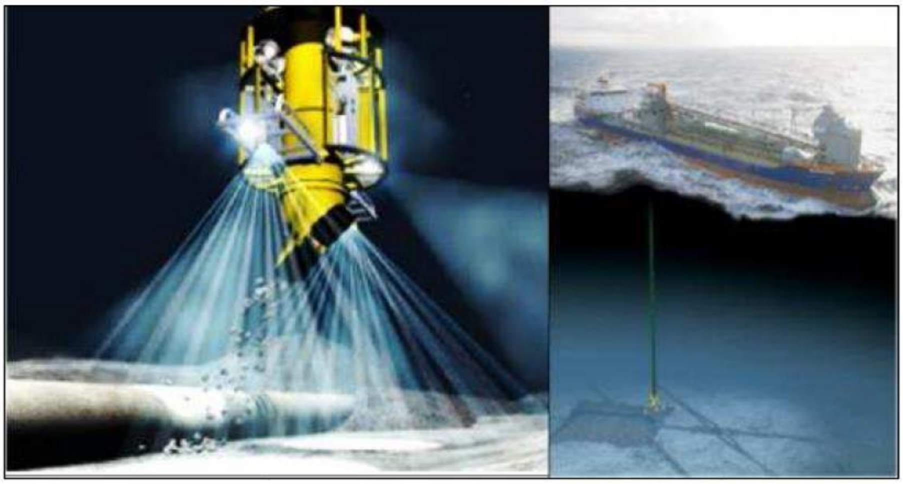


Figure 5.28: Machinery used for rock dumping

This technique is also applied for filling limited areas, where geomorphological features require to create a base for the cable, avoiding the generation of sections of the cable that are loose and free to oscillate.

Figure 5.29: Cable cover by rock dumping

5.2.3.4 Deterrents

Deterrents are systems used for protection against trawling, generally made in concrete and shaped for their role. These are placed on the seabed in order to intercept trawling nets and minimize human activity in the area where the cable is installed.

They are laid:

- at a minimum distance from the cable of approximately 50 cm in order not to obstruct monitoring and repair activities;
- at depths greater than 10–15 m, given their height of some meters.

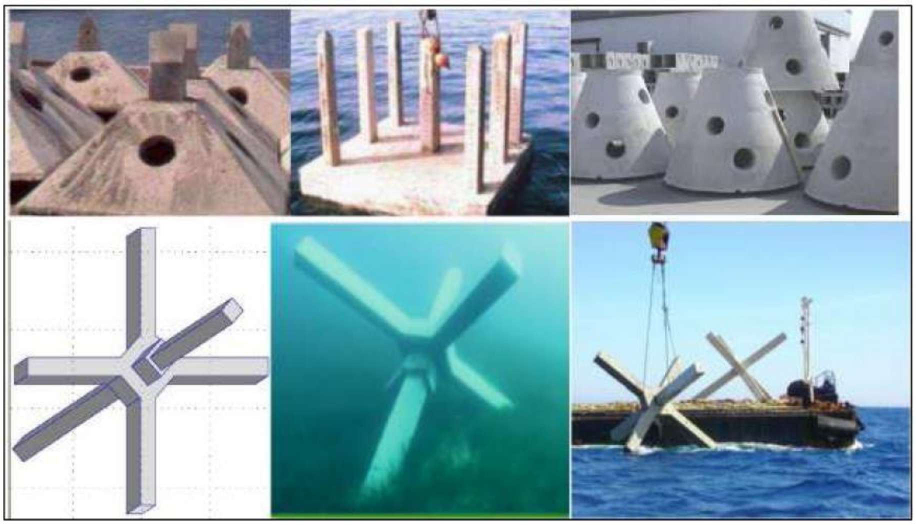


Figure 5.30: Example of deterrents for protecting undersea cables

5.2.4 Service crossings at sea

Crossing of other undersea utilities, such as communication cables or gas pipelines, will require specific solutions.

Depending on the depth and the status of the crossed utilities, various techniques may be adopted in order to guarantee the physical separation of the power cable, such as shells in plastic material, concrete mattresses, sacks filled with sand or other aggregate materials, etc..

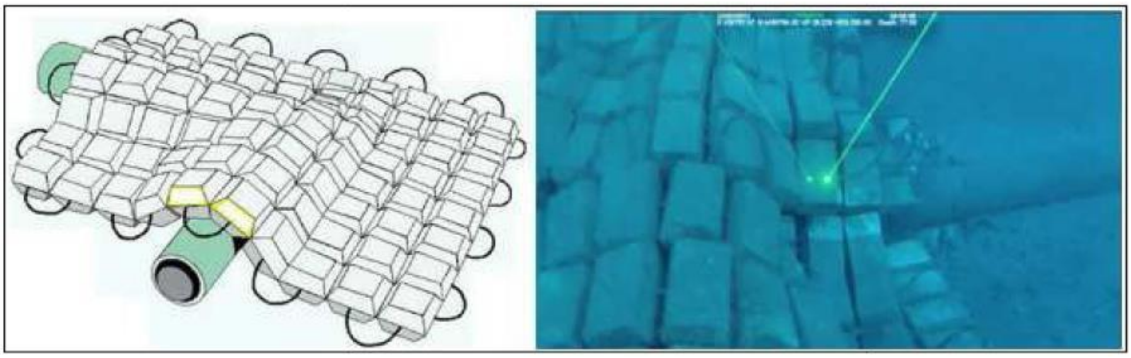


Figure 5.31: Examples of concrete mattresses for protection of a pipeline

5.3 Construction duration and timing

The total duration of works is estimated to be approximately 4 years, including testing and final commissioning of the electrical link.
The following table illustrates the construction time estimated for the various works.

Table 5.3: Construction time estimated for main works

Works	Duration
Mlaâbi Converter Station	40 months
Marine power cable from Tunisia to EEZ limit	2,5 months
Marine electrode cable	2 months
HVDC underground cable Mlaâbi – Kelibia	6 months
OHL Mlaâbi - Mornaguia	24 months
Associated facilities	
Partanna Converter Station	40 months
Marine power cable from Italy to EEZ limit	2,5 months
Marine electrode cable	2 months
HVDC underground cable Partanna – Marinella di Selinunte	22 months
HVAC underground cable Partanna CS – Partanna Station	6 months

5.4 Use of resources

The following table synthetize the quantities of the main materials used for the construction.

Table 5.4: Quantities of the main materials

Material	Quantity
HVDC terrestrial cable line	
Concrete	420 m^3/km
Power cable	35 t/km
Optical cable	190 kg/km
PEAD pipe	22 kg/km
HVAC terrestrial cable line	
Concrete	420 m^3/km
Power cable	210 t/km
Optical cable	190 kg/km
PEAD pipe	18 kg/km
HVDC marine cable line	

Power cable	45 t/km
Electrode cable	15 t/km
Optical cable	2 t/km
Converter Station	
Concrete	18,000 m^3
Armor iron	1,500 t
Carpentry	30 t
Cabling	270 t

All natural materials, including water and aggregates, will be supplied by licensed suppliers, to be approved by STEG.

5.5 Waste generation

Waste generated during construction is primarily composed by:

- Excavated soil, both in the area of the CS and along the cable route;
- Debris from demolition of pavements;
- Drilling mud for HDD activities.

The Contractor shall avoid the generation of hazardous and nonhazardous waste.

Where waste generation cannot be avoided, the Contractor shall minimize the generation of waste, and reuse, recycle and recover waste in a manner that is safe for human health and the environment. Where waste cannot be reused, recycled or recovered, the Contractor will dispose of it in an environmentally sound and safe manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material.

If the generated waste is considered hazardous, the Contractor will comply with existing requirements for management (including storage, transportation and disposal) of hazardous wastes including national legislation and applicable international conventions, including those relating to transboundary movement. When hazardous waste management is conducted by third parties, the Contractor will use subcontractors that are reputable and legitimate enterprises licensed by the relevant government regulatory agencies and, with respect to transportation and disposal, obtain chain of custody documentation to the final destination. The Contractor will ascertain whether licensed disposal sites are being operated to acceptable standards and where they are, will use these sites.

6. DESCRIPTION OF THE OPERATION PHASE

6.1 Operational activities

All equipment and plants of the project will be managed and controlled remotely by the appointed Italian and Tunisian Operations Centre.

Also in the Mlaâbi Converter Station, presence of permanent personnel will not be required: the CSs will have Control, Automation and Remote-Control Systems which, in normal operating conditions, will allow complete remote control of the plant from one of the Terna Integrated Remote Control Centers (CTI). In particular operating and/or maintenance situations, the station can also be managed at local level by the emergency support personnel.

The Control and Automation System will supervise both the correct functioning of the AC-DC Converter equipment (Conversion Bridge, Converter Transformers etc.), and the traditional systems and equipment (SPCC) interfacing the CS with the HV Grid.

The Control and Automation System will manage the “new Italy - Tunisia interconnection” connection in different operating procedures in relation to the multiple network needs (e.g., import or export, power control, frequency regulation) or failure situations of various systems or devices (e.g., malfunction of the telecommunications system). The redundancies and the physical and logical configuration of the Control System will be such that the failure or voluntary decommissioning of an element of the system, or of the communication, will only result in the partial degradation of the overall performance.

The Control System will have system diagnostics that will constantly allow overall monitoring of the station both remotely and locally, thus allowing online control and emergency response.

The Remote Control and Telecommunication Systems will fulfil the twofold need for coordinated control and implementation of protective actions during normal and fault operation between the two conversion terminals in the Partanna and Mlaâbi stations, and for the exchange of information between the two converter plants and the Integrated Remote-Control Centers.

The Converter Stations will therefore be equipped with telecommunications equipment which will guarantee, with the appropriate redundancies, the transmission of information and data to the various recipients, via optical fiber connections and alternative emergency channels. Any interruptions or deterioration of the transmission links will result in automatic switching to reserve connections or to particular operating arrangements of the Converter Stations, ensuring as far as possible the continuity of operation and the safety of the plants.

6.2 Maintenance

During the operational phase of the project, STEG personnel will carry out regular inspections along the underground cable and overhead lines.

Regular maintenance work will be carried out by specialized teams, whilst extraordinary maintenance works will require procedure (and induce impacts) similar to those of the construction phase.

7. PROJECT ALTERNATIVES

7.1 Landfall project alternatives

Two landfall project alternatives were proposed and analyzed in the preliminary study "RVFR18400A00014, REV02,13/04/2022, Nearshore Marine Report – Tunisian Side", by RINA-COMETE: Kelibia and Menzel Horr: the two alternatives are shown in the following figure.
Geophysical investigations were carried out (see above mentioned report) in order to evaluate the technical feasibility of the landfalls and to evaluate the best possible routing for power and electrode cables.

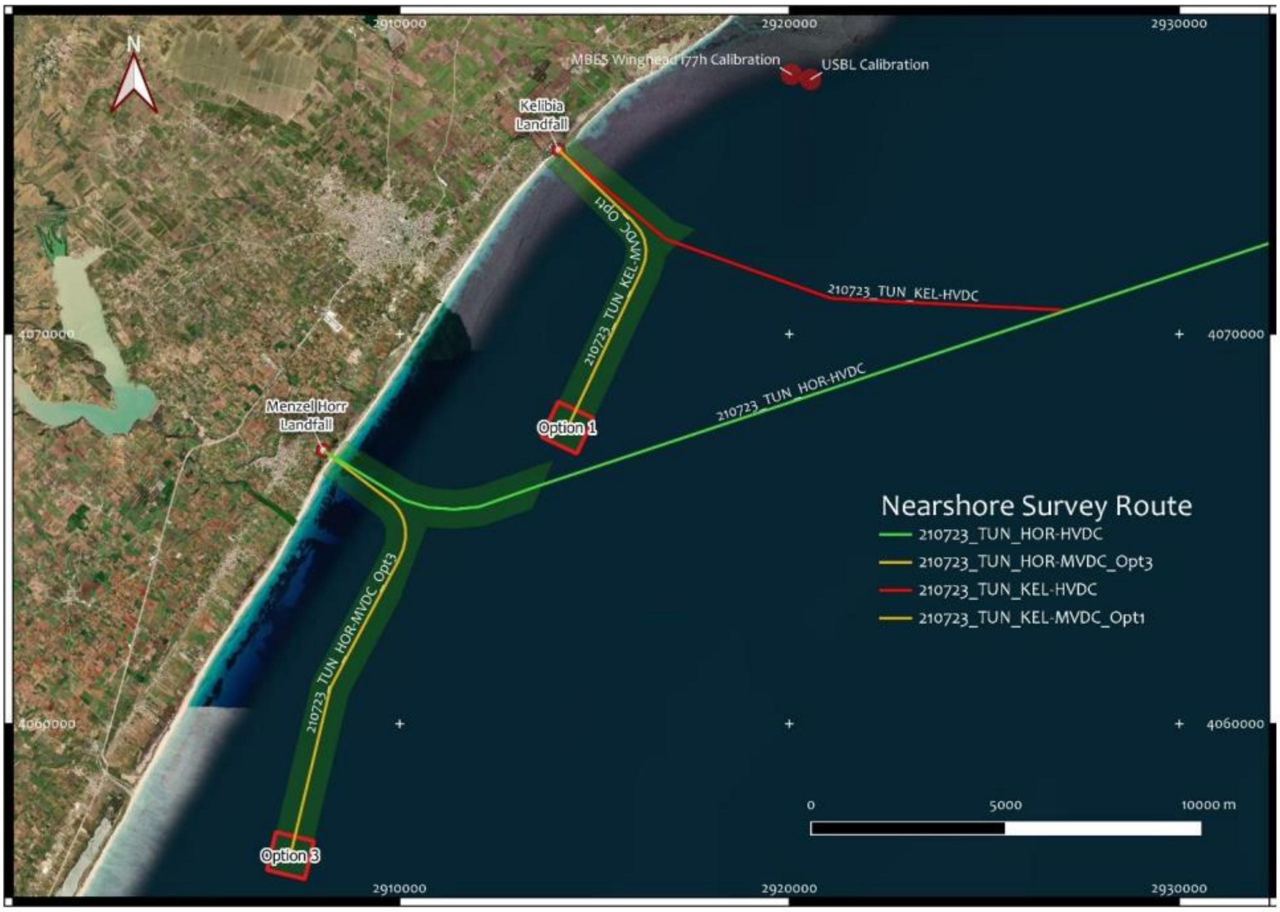


Figure 7.1: Alternative landing options: investigated routes for power and electrode cables

7.2 Terrestrial cable route project alternatives

Each of the above illustrated landfalls determined a set of possibilities for the terrestrial route of the underground cables; the studied alternative terrestrial routes are illustrated in the study "RGFR18400A201, REV01, 6/05/2021, Terrestrial DTS Report -Tunisian side" by COLENCO and shown in the following figure.
The length of the route from the landing point to the Mlaâbi converter station is about:

- 9 km for the Kelibia landfall;
- 13,5 km for the Menzel-Horr landfall.

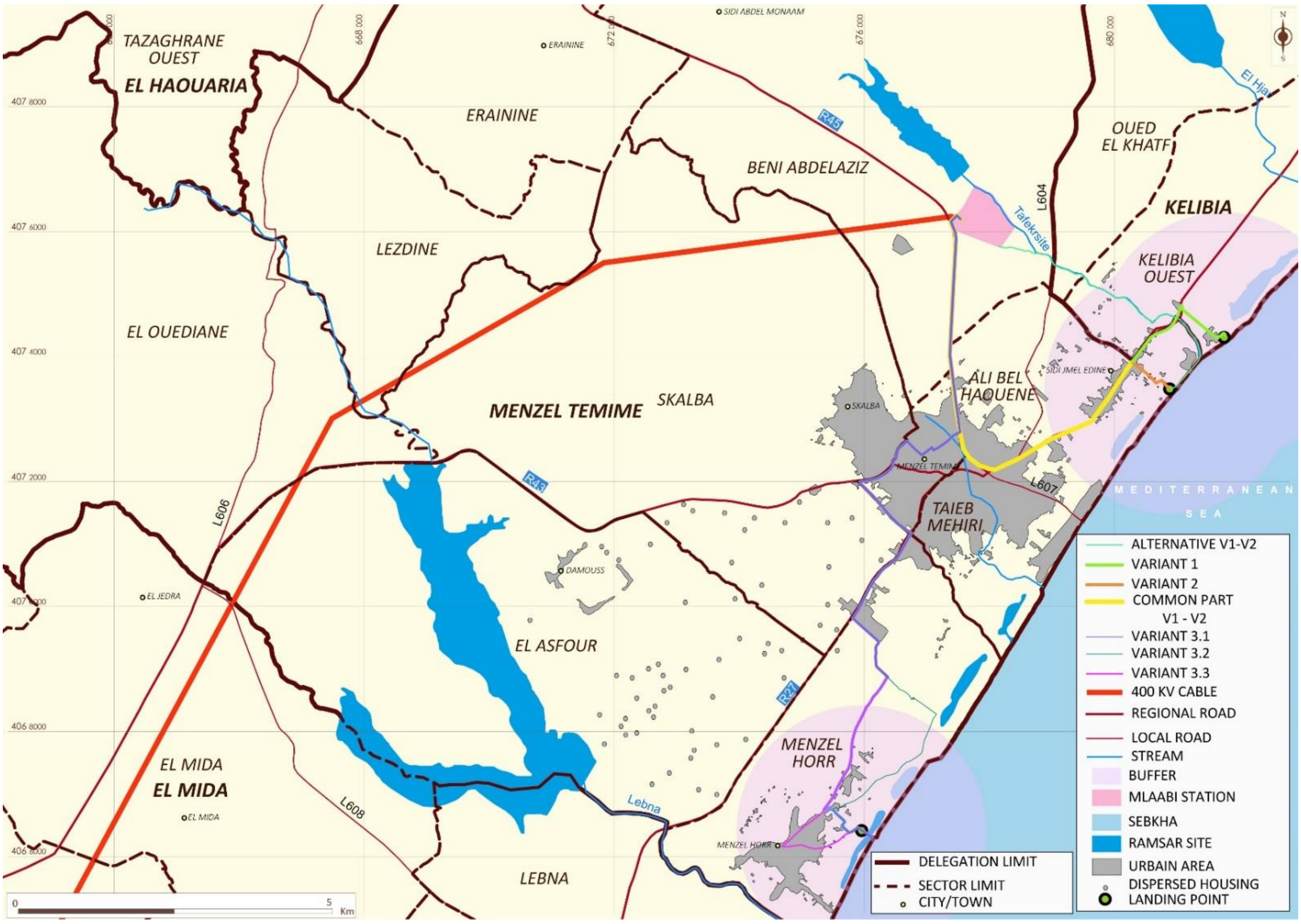


Figure 7.2: Alternative routes for terrestrial cables (in different colors) for the two alternative landing points of Kelibia and Menzel-Horr

7.3 Overhead line project alternatives

The OHL line has not been the subject of a detailed study of route alternatives because the analysis of land use between the CS of Mlaabi and the Mornaguia station reveals a multitude of technical constraints which means that the only possible corridor for the OHL line is the one proposed by STEG to ELMED.

However, this corridor was the subject of a critical environmental and social analysis (by the same JV in charge of E&S studies) which made it possible to highlight the environmental and social constraints that must be taken into account when choosing an optimized route inside this corridor.

On the other hand, this ESIA makes it possible to verify that the passage corridor of the OHL line does not cross critical or threatened habitats as defined by ESS6. The ESIA also made it possible to identify the Key Biodiversity Areas located in the direct area of influence of the Project (6 km strip on either side of the line axis). These consist of the Zaghouan aqueduct and five dams (Artificial Wetland), four of which are classified internationally as Ramsar Areas.

7.4 Offshore project alternatives

Three alternatives for the offshore route were analyzed in the first stages of the project development: analysis is described in the preliminary study “RVFR18400A00012, REV02, 9/07/2022, DTS Report” by RINA COMETE”, and are shown in the following figure.

The choice for the project route, that was investigated through a detailed marine survey was based on a desktop study; the offshore reconnaissance survey area consisted in a corridor NE-SW oriented, 3000m wide and approximately 187 km long.

The final route was then identified as a result of the reconnaissance survey, taking into account all the constraints identified on the sea bottom.

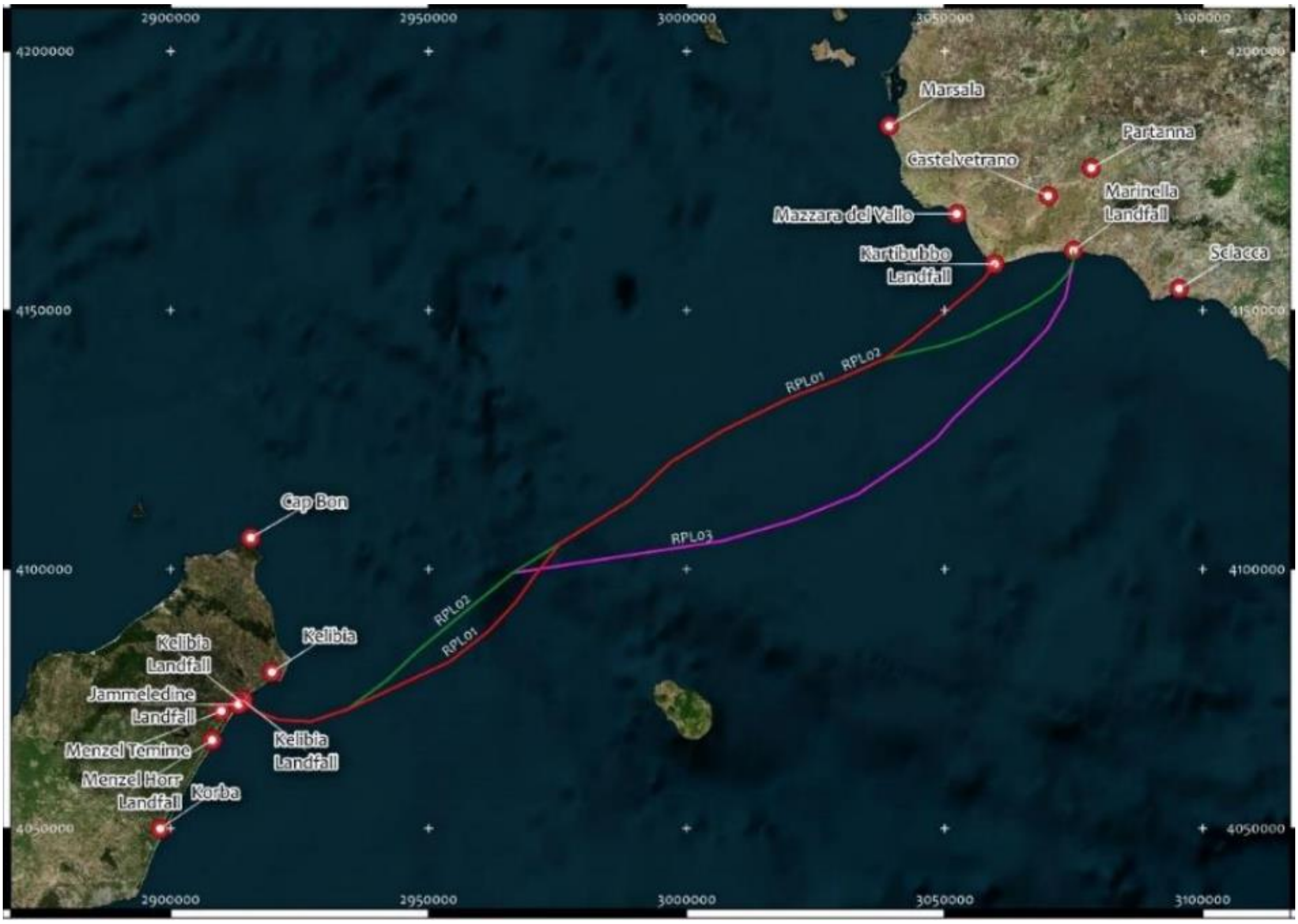


Figure 7.3: Marine cable alternative routes