# HV/EHV Cables Technology: Onshore – Offshore

CABLEL®
HELLENIC CABLES
GROUP

George Georgallis
Cable Engineering & Marketing Mgr.

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HELLENIC CABLES S.A.
HELLENIC CABLE INDUSTRY S.A.

FULGOR S.A.
HELLENIC CABLE INDUSTRY

ICME ECAB S.A.
CABLE INDUSTRY

# Cenergy Holdings

VIOHALCO

- Aluminum
- Copper
- Steel
- Steel Pipes
- Cables
- Real Estate
- Technology R&D
- Recycling

CORINTH PIPEWORKS

CABLEL HELLENIC CABLES

Cross-Border merger

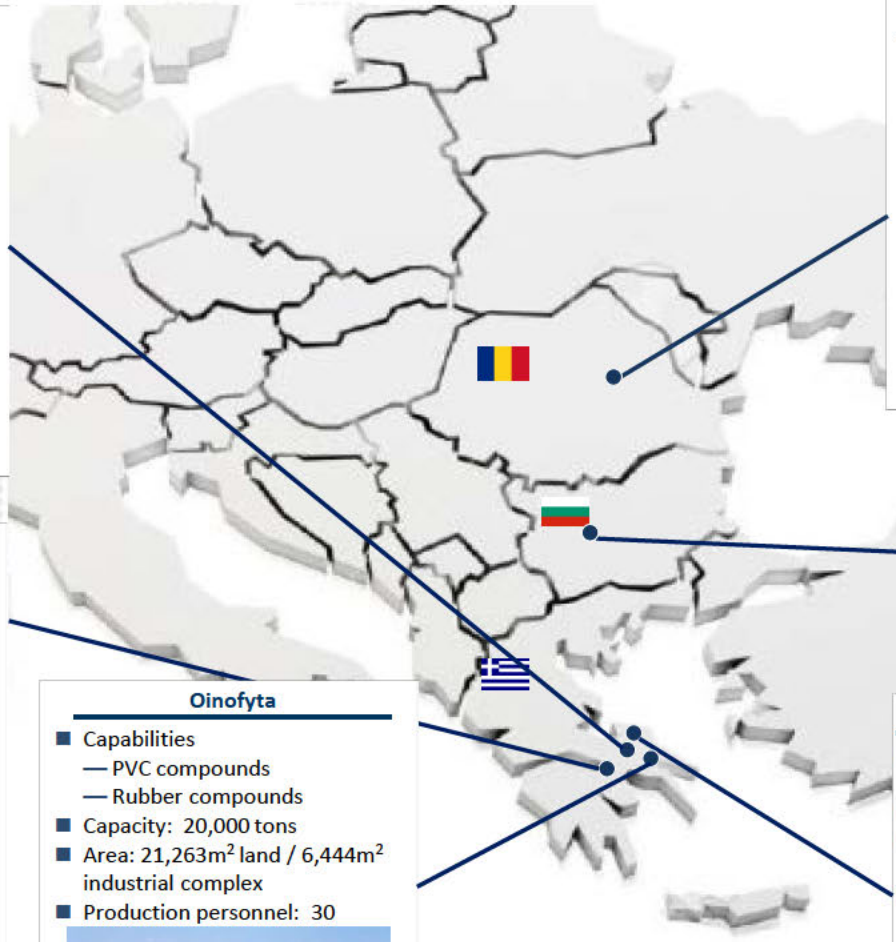
focus on

energy sector

CENERGY HOLDINGS

# Production Facilities

**Hellenic Cables operates six production plants, of which four in Greece, one in Romania and one in Bulgaria**



### Thiva

- Capabilities
  - LV/MV/HV power cables
  - Fibre optic cables
- Capacity: 60,000 tons
- Area: 175,082 $m^2$ land / 44,408$m^2$ industrial complex
- Production personnel: 245

### Fulgor

- Capabilities
  - MV/HV submarine cables, LV/MV/HV power cables, fibre optic submarine
- Capacity: c. 60,000 tons of cables and c.120,000 tons of wire rod
- Area: 218,247 $m^2$ land / 80,048 $m^2$ building facilities
- Production personnel: 150
- Docking facilities for loading submarine cables onto cable laying vessels

### Oinofyta

- Capabilities
  - PVC compounds
  - Rubber compounds
- Capacity: 20,000 tons
- Area: 21,263$m^2$ land / 6,444$m^2$ industrial complex
- Production personnel: 30

### ICME ECAB

- Capabilities
  - Power cables
  - Telecommunication cables
- Capacity: 60,000 tons
- Employees: 600
- Area: 268,000 $m^2$ land / 70,000 $m^2$ industrial complex

### LESCO

- Capabilities: wooden packaging products (pads, reels, pallets, packing cases), including wooden spools
- Capacity: 16,500 $m^3$
- Employees: 70
- Area: 25,000 $m^2$

### Livadia

- Capabilities: Cu and Al round and flat
- Capacity: 12,000 tons
- Area: 121,818$m^2$ land / 14,048$m^2$ industrial complex
- Production personnel: 50

Major Product Groups

# Wide Product Range

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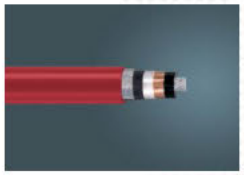
**Hellenic Cables serves blue chip customers across a range of attractive and growing end-markets including electricity distribution, construction, renewables and telecommunications**

## Power Cables



- High and extra-high voltage cables
- Medium voltage cables
- Low voltage cables

**Markets**

- Power transmission & distribution
- Construction and infrastructure
- Renewable energy

## Submarine Cables

- HV & EHV submarine
- MV submarine cables
  - Paper insulated
  - XLPE, EPR insulated
  - Composite power
- Optical fibre submarine
- Umbilicals
- Flexible pipes

**Markets**

- Renewable energy
- Power transmission & distribution
- Oil & gas

## Telecom Cables

- Telecommunication network cables
- Optical fibre cables
- Data transmission
- Signaling, instrumentation and control cables

**Markets**

- 3G/4G/5G mobile networks
- FTTH networks
- Railways
- Oil & gas

## Enameled Wires

- Magnet / enameled wire for transformers
- Magnet / enameled wire for motors
- Al and Cu round and flat magnet wires

**Markets**

- Motor and electric
- Electronic information
- Household appliances

## Established Relationships and Solid Track Record with Blue Chip Customers

### Utilities

### Trade & Installers

### Industrial

# High & Extra High Voltage Land Cables up to 500 kV

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# Production and Quality Control Process

## HV & EHV Underground Cables

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### 1. In-house Rod Production

- In-house continuous Cu casting for production of 8mm Cu rod
- In-house continuous Al casting for production of 9.6mm Al rod


### 2. Conductor Formation

- Wire drawing from Cu / Al rod
- Wire enameling
- Conductor stranding


### 3. Insulation

- The insulation system is applied in three layers applied simultaneously through a triple extrusion cross head and dry cured in a nitrogen filled catenary tube. Special attention is given to the material handling, which is performed inside clean rooms. The extruders are also inside clean rooms.

## Quality Control


# Production and Quality Control Process
## HV & EHV Underground Cables

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### 4. Degassing

During this process the core is heated by warm air for the time required to complete the degassing of the insulation, thus removing all gaseous by-products

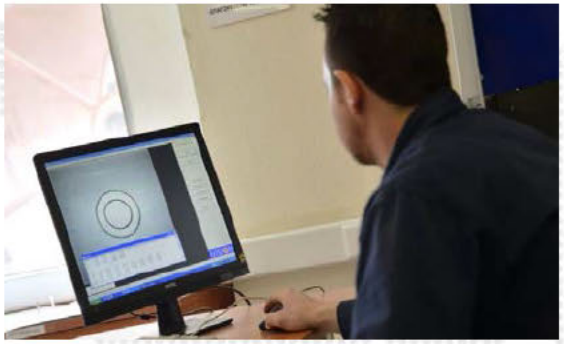
### 5. Screening

- A lead alloy sheath with or without copper wires beneath
- Copper wires screen with aluminium or copper foil laminate
- Aluminium wires screen with aluminium foil laminate
- Smooth or Corrugated Welded aluminium with or without copper wires beneath

### 6. Oversheathing

An extruded polyethylene oversheath is applied with semiconducting conducting coating.

# Production and Quality Control Process
## HV & EHV Underground Cables



### 7. Quality Control

- Group strategic orientation to high added value products , resulted in the investment of advanced high voltage laboratories in Thiva, Corinth and Oinofyta plants.
- HV and EHV cables are tested according to international and / or specific customers' standards.

- The factory is equipped with new testing facilities in order to perform prequalification and type testing
- Corinth (Submarine) plant laboratory is in the initial stage of accreditation according to ISO 17025. Full accreditation is expected to be attained by summer 2018.
- Thiva and Oinofyta plants will follow.

- Testing takes place during all the above mentioned intermediate production phases and on the finished product.
- The plant is equipped to perform all required electrical and non electrical testing as well as type testing and prequalification testing
- Additional testing:
  - X-linking degree (Gel content)
  - Thermal history after degassing
  - Degassing degree (Methane ppm)
  - Deterioration point (Ageing)

# Test Programme

## EHV Qualifications:

**Existing qualifications:**

- System PQ test at 400 kV completed in 2011
- Cable type test at 400 kV completed in 2013
- System type test at 220 kV completed in 2012
- System type test at 400 kV completed in 2015
- System PQ test at 400 kV completed in 2017

## HV Qualifications:

- System type tests performed with several accessories manufacturers
- Continuous type testing with alternative accessories manufacturers according to international or national standards and customised to specific customer requirements.

# Submarine Cables up to 400 kV

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# After acquisition, the Group launched an extensive investment plan in order to upgrade and extend Fulgor's manufacturing and testing capacities

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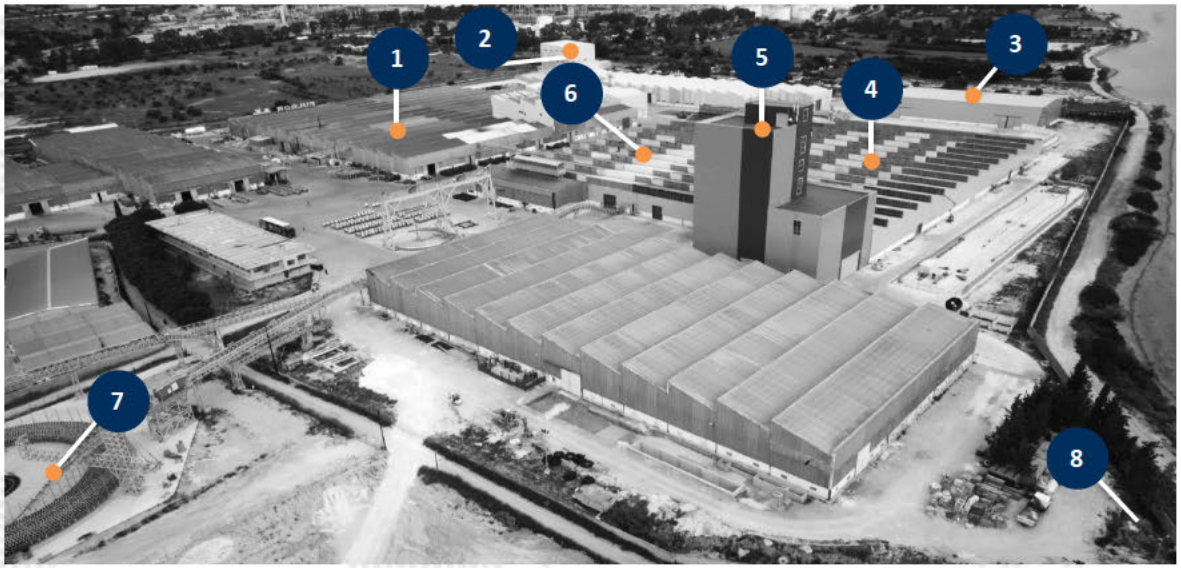
**Production and Testing of XLPE insulated submarine cables up to:**

- 400 kV for AC 1c – 3c
- 400 kV for DC




**1 Stranding Line**

**2 Insulation**

**3 Degassing Rooms**

**4 PE and Pb Extruders**

**5 Vertical Laying-up**

**6 Armouring**

**7 TurnTable**

**8 Dock Facilities**

# Main New Equipment / Upgrades in HV Submarine Cable Production Process

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## 1. In-house Rod Production

- In-house continuous Cu casting for production of 8mm Cu rod
- In-house continuous Al casting for production of 9.6mm Al rod

## 2. Conductor Formation

- Line upgrade
- New basket take up for storage of long continuous conductor lengths before insulation

## 3. Insulation

- Line and quality control upgrades in both insulated lines
- New granule feeding system for extra cleanliness of insulating material with on line granule quality control

# Main New Equipment / Upgrades in HV Submarine Cable Production Process

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## 4. Degassing

- New degassing chambers
- The insulated cores are coiled on turn tables which are placed inside the degassing chambers
- During this process the chambers are heated and warm air recirculates for the time required to complete the degassing of the insulation, thus removing all gaseous by-products

## 5. Pb & PE Sheathing

- Upgraded sheathing lines
- After degassing, the cores are covered first with semi-conductive water blocking tapes and by a Pb alloy sheath of a suitable composition and thickness to achieve radial protection against water penetration
- The Pb sheath is applied with a continuous extrusion process. It is followed by a semi-conductive PE sheath

# Main New Equipment / Upgrades in HV Submarine Cable Production Process

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## 6. Vertical Laying up

- *New* vertical laying up line
- The cores which are placed on turntables are paid off upwards along the optical fibre units and control cables (If applicable), they pass through the stranding die, the capstan and the bundled cable is coiled on the intermediate turntable
- The turntables of the line have the largest capacity for carrying the maximum length of the power cores, in order to avoid or minimize the number of factory joints in the final cable
- If factory joints are required they are constructed for each core. This way one core length is jointed to the core length that follows. Jointing takes place before the standing process and until the final cable length is achieved

## 7. Armouring

- New armouring line
- After laying up, various protective layers are applied to the cable, mainly for its mechanical protection such as steel wires, bitumen, PP yarns, etc.
- All the above layers are applied at the armouring line and the finished cable is collected on the final turntable

# Main New Equipment / Upgrades in HV Submarine Cable Production Process

## 8. Storage

- Intermediate and final storage of the HV submarine cables take place on turntables

- New intermediate and final storage turntables with highest storage capacity

- New roller ways to route WIP and finished cables to the turntables and to the loading point at Fulgor factory port

# HV Submarine Cables Quality Control

## 9. Quality Control

- New testing facilities
- Testing takes place during all the above mentioned intermediate production phases and on the finished product

- The factory is equipped with new testing facilities in order to perform prequalification and type testing
- Corinth plant laboratory is in the initial stage of accreditation according to ISO 17025. Full accreditation is expected to be attained by summer 2018.

- As there is no standard covering all tests on high voltage submarine cables, the equipment and tests are based on IEC 60840 and CIGRE recommendations / ELECTRA (No171 April 1997, No189 April 2000) or their most recent editions

# Type Test Programme

## EHV Qualifications:

- System PQ test at 220 kV
- System type test at 220 kV
- Extension PQ test at 220 kV with asymmetrical joint

## HV Qualifications:

- Cable type tests at 150 kV with several cable constructions
- Continuous type testing according to specific customer requirements.

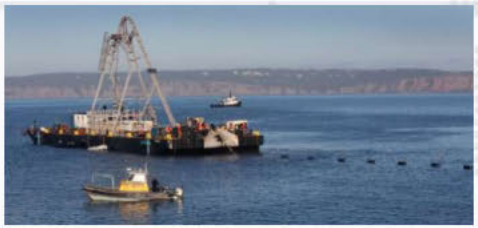
# Investment has been completed and provides additional distinctive capabilities…

## Direct Loading on Cable-laying Vessels

- The HV submarine cables will be loaded from the final storage turntables through **dedicated loading lines** on the turntables of cable-laying vessels which will arrive at **Fulgor port**
- Fulgor port is able to accommodate **all cable-laying vessels** currently in operation

## Turnkey Solution Provider

- **Onshore** and **Offshore**
- Scope including **full service range** from engineering, cable manufacture and supply, accessories supply, cable system installation and protection, on site commissioning tests and customer personnel training in operation and maintenance



# Thank you for your attention!

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