Technology challenges for addressing submarine interconnections

TGEG'19 **27 June 2019**

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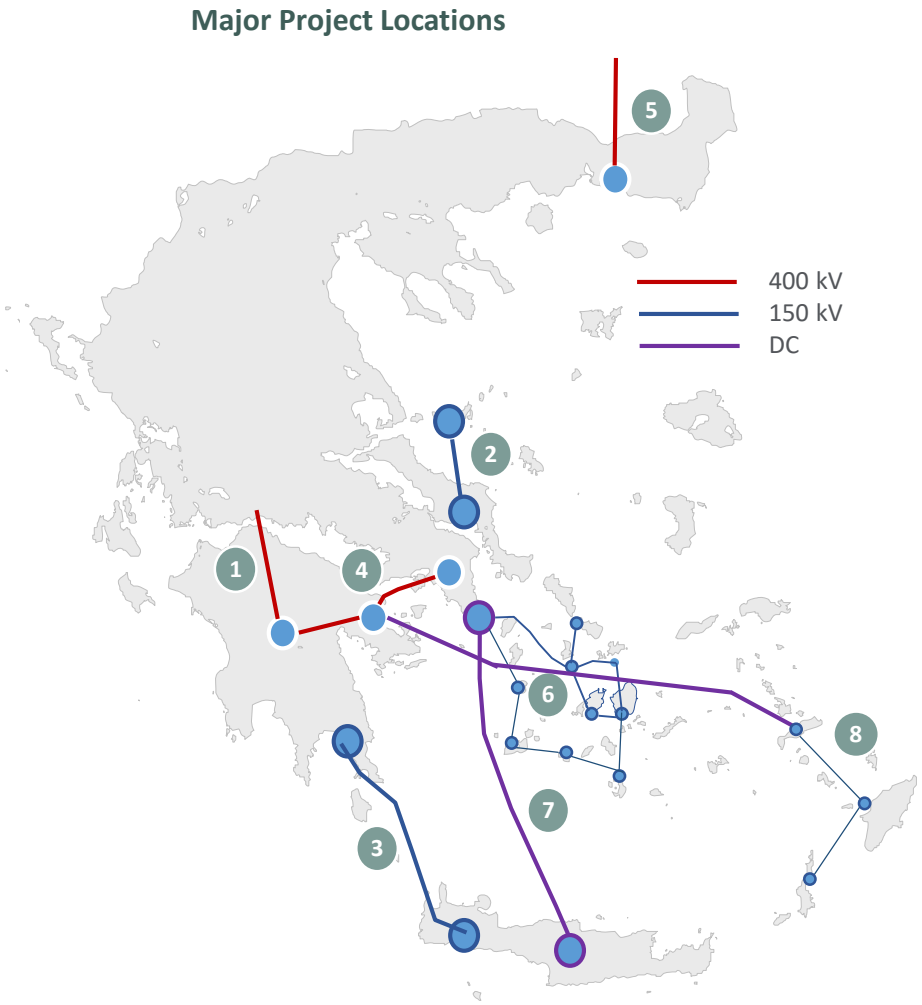
ΑΔΜΗΕ
ΑΝΕΞΑΡΤΗΤΟΣ ΔΙΑΧΕΙΡΙΣΤΗΣ ΜΕΤΑΦΟΡΑΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ

ARIADNE
INTERCONNECTION

ADMIE Major Projects



ID	Project description	Expected commissioning year
1	First 400 kV branch to Peloponnese (OHL Megalopoli – Patras – Acheloos)	2019
2	Skiathos island interconnection	2021
3	Crete interconnection (Phase I)	2020
4	Second 400 kV branch to Peloponnese (OHL Megalopoli – Korinthos – Koumoundouros)	2024
5	New 400 kV interconnector to Bulgaria N. Santa (GR) – Maritsa (BG)	2023
6	Cycladic Islands interconnection (Phases B', C' and D')	2024 (2019 for Phase B', 2020 for Phace C' and 2024 for Phase D')
7	Crete interconnection (Phase II)	2022
8	Dodecanese Interconnection	2027

Source: TYNDP 2020 – 2029 (under public consultation)

Islands Interconnection: Main Drivers

- **Reliable and stable operation** of the islands with significant benefits for tourism and general economic activity
- **Reduced environmental impact** on the islands due to the phasing out of autonomous thermal power plants
- **Reduced energy cost**
- **Reduced charges** of services of general interest
- Exploitation of the **RES potential** of the islands
- Increasing maturity of **Offshore Wind** Technology

Islands Interconnection: Challenges (1)

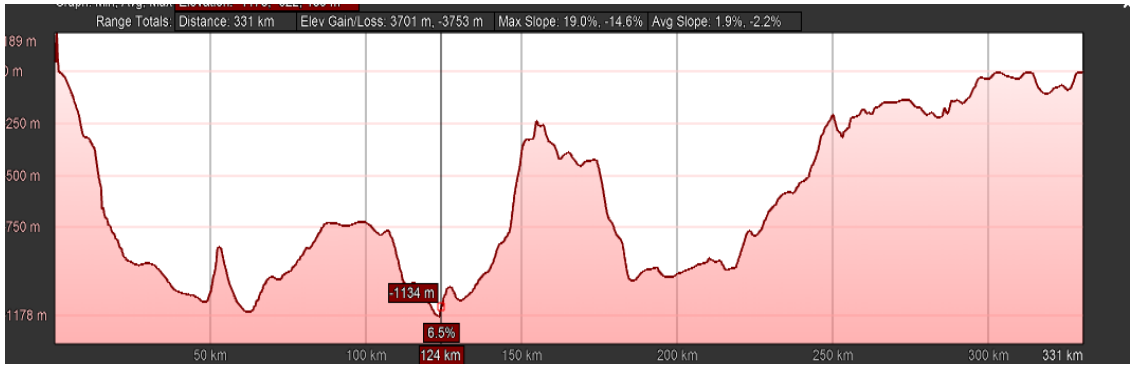
Interconnection Lengths – Sea Depths – Terrain

Example: Crete Interconnection

AC Interconnection: 135km, 980m (longest/deepest AC link in the world)

DC Interconnection: 380km, 1250m

Hard soils, extreme slopes, shipwrecks, earthquakes etc.



Projects with Similar Challenges in Europe

SAPEI: Sardinia-Italy, depth 1650 m, 420 km long

MONITA: Italy-Montenegro, depth 1200 m, 415 km long

SKAGERRAK IV: Denmark-Norway, depth 550 m, 137 km long

NORD.LINK: Germany-Norway, depth 230 m, 623 km long

NSL: UK-Norway, depth 600 m, 730 km long

Islands Interconnection: Challenges (2)

Reliability – Interconnecting Weak Systems

- Interconnections for ensuring the energy supply of islands
- Requirement for increased reliability
- Time constraints for construction, availability, maintenance, fault restoration etc

Example: Crete has a peak load of 650MW with 600.000 residents (even more in summer)

- Interconnection of weak systems (with potential high RES penetration): system stability, voltage control etc
- New power system structure: AC/DC interconnections, high RES penetration
- Requirement for advanced system operation and protection schemes

Example: Crete weak system will operate with AC and DC links, facing increased RES (wind) penetration

Islands Interconnection: Challenges (3)

Surrounding Environment

- **SPACE**: Islands (especially in the Aegean sea) face great space limitations. This leads to difficulties in installing substations and other relative infrastructure.
- **NAVAL ACTIVITY**: The Aegean sea (and Mediterranean in general) is characterized by intense naval activity that poses risks for submarine cables (trawling, anchors etc.).
- **EXISTING CABLES**: A variety of submarine cables/pipes are already installed in the Mediterranean sea (different types of crossings must be studied).
- **ARCHAEOLOGICAL FINDINGS**: Both in the submarine and land parts of the interconnections.

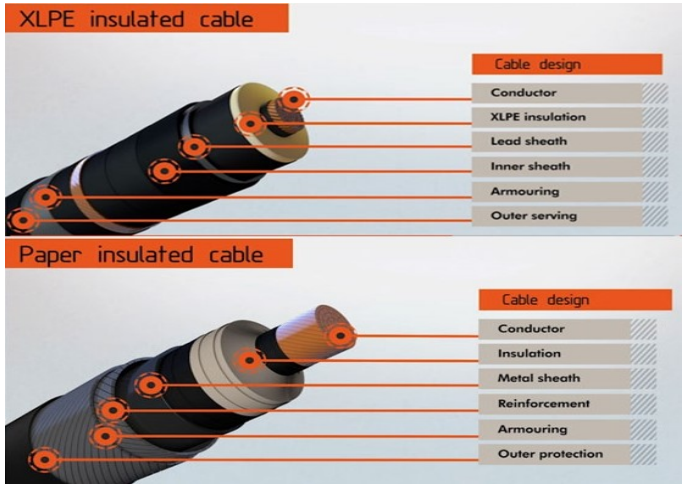
Islands Interconnection: Challenges (4)

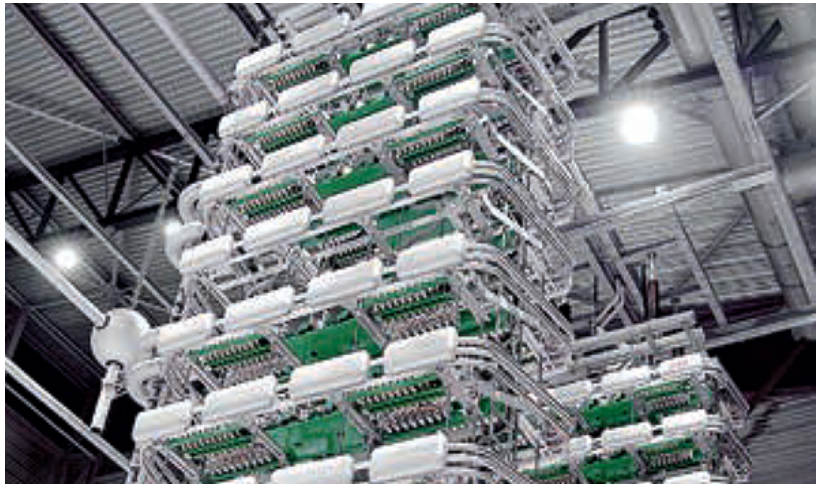
Cable Industry

- **Production Capacities:** competing projects-tenders
- **Vessel Availability:** deep sea requirements
- **Technology Maturity:** need for safe innovation – risk assessment of innovative solutions
- **Market Consolidation Signs:** changing market environment

Solutions: Sea depth – length – terrain

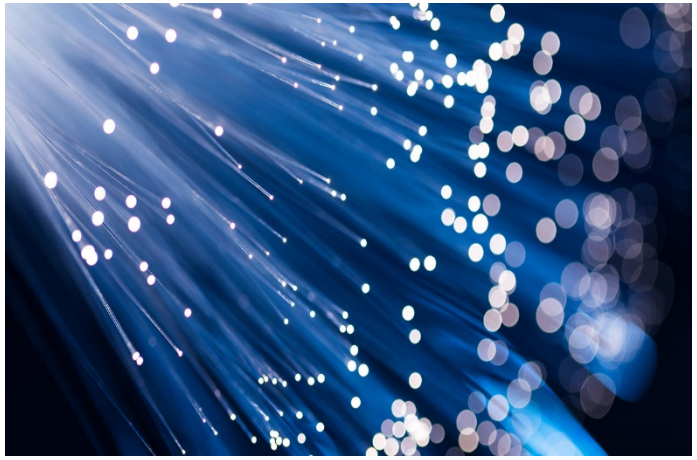
- **Cable technologies:** XLPE cables for HVAC - MIND and XLPE cables for HVDC interconnections
- **Cable core material**: Choice between Cu and Al depending on total costs, losses and weight
- **Cable armoring**: New solutions for lighter cables such as Synthetic armoring. First implementation in Evia-Andros-Tinos interconnection project
- **HVAC/HVDC**: Moving towards HVDC for long interconnections
- **Voltage level**: Moving towards higher voltage levels
- **Cable laying vessels**: New vessels able to manage heavier load and suitable for cable laying in large sea depths





Solutions: Reliability-Operation

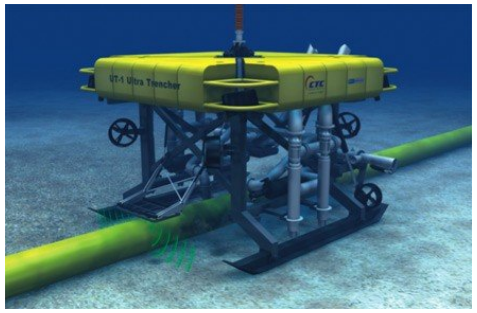
- **STATCOM/SVC:** Reactive power compensation for voltage control in the interconnected islands (e.g. installed SVC in Syros – Cyclades Phase I)
- **Advanced Control Center:** New Control Center in Crete communicating with the National Control Center in Athens.
- **Protection schemes for hybrid AC/DC systems:** State-of-the-art protection schemes in Crete
- **Multi-terminal HVDC:** Provisions for connections with other HVDC systems in the region (HVDC grid)
- **Enhanced communications:** Dedicated Fiber Optic cables are laid with the power cables used both for power system operation and for providing communication services



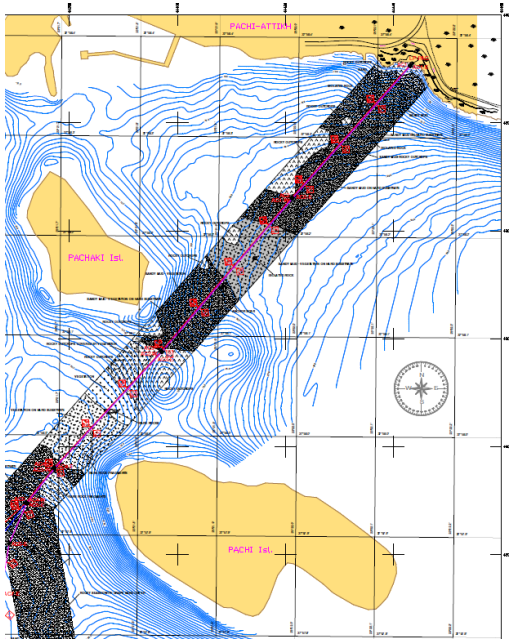
Solutions: Surrounding Environment Challenges

Civil/Mechanical/Naval engineering

Burial assessment/Cable protection



Marine surveys



Community/local authorities engagement

High Voltage GIS

Cable/pipe crossing studies