Discussion Group 2
The economics of Mediterranean electricity exchanges

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Tunis, 27.05.2016
Discussion Group 2
The economics of Mediterranean electricity exchanges

- Mediterranean interconnections: where are we now?
  - North-North interconnections: key drivers
  - South-South and North-South interconnections: key drivers
  - Main results of available studies on Mediterranean interconnections
  - Main obstacles to expanding electricity exchanges
  - Questions and debate
Overview of the power system pools around the Mediterranean basin

Two synchronous power pools:
- ENTSO-E, Turkey, Maghreb
- Mashrek

Isolated systems:
- Israel; Cyprus; Crete

**ENTSO-E**
- Demand: 3210 TWh
- Installed capacity: 1024 GW

**Turkey**
- Demand: 264 TWh
- Installed capacity: 74 GW

**Israel**
- Demand: 54 TWh
- Installed capacity: 14 GW

**South & West Med Countries**
- Demand: 117 TWh
- Installed capacity: 28 GW

**South & East Med Countries**
- Demand: 265 TWh
- Installed capacity: 58 GW

Data referred to 2014; for Turkey: data referred to 2015
Euro-Med region: axes of development

Different drivers prompting interconnections along the various axes.
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North-North interconnections: key drivers

- **2020** Climate and energy package
  - 23 April 2009

- **2030** Framework for climate and energy policies
  - 23 October 2014

- **2020-2030** Energy Union Package
  - 25 February 2015

- **2050** Roadmap for moving to a low-carbon economy

Integration of RES generation

Integration of energy and ancillary service markets
Role of Interconnection for power exchanges: evolution in Europe

<table>
<thead>
<tr>
<th>Years</th>
<th>Role of interconnections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1970</td>
<td>♦ Reserve and mutual support facing large perturbations</td>
</tr>
<tr>
<td>1980-1990</td>
<td>♦ Energy exchanges on the basis of pre-established contracts (usually long term contracts)</td>
</tr>
<tr>
<td>2000-</td>
<td>♦ Cross-border exchanges based on short-mid term contracts</td>
</tr>
<tr>
<td>2005-</td>
<td>♦ Mean to foster a higher penetration of RES</td>
</tr>
</tbody>
</table>
North-North interconnections: achievements and developments

The European Vision

From vision to reality

EU renewable energy potential and future electricity infrastructure needs

Norway-UK
Norway-Netherlands
Norway-Germany
North-North interconnections: achievements and developments

**Piedmont-Savoy**
- 2x600 MW HVDC-VSC
- Length: 190 km – whole link in cable (XLPE)!
- Cable laying in tunnels: Fréjus (10 km), Bussoleno (6 km) and dozen of motorways viaducts
- Estimated CAPEX: 1,4 b€

**Italy-Montenegro**
- 2x500 MW HVDC-LCC
- Length: 415 km
- Cable laying: 390 km submarine
- Estimated CAPEX: 0,8 b€

**France-Spain**
- 2x1000 MW HVDC-VSC
- Length: 64,5 km – whole link in cable (XLPE)!
- Cable laying in tunnels: Pertus (8,5 km) to cross Pyrenees
- CAPEX: 0,7 b€ (225 M€ from EEPR)
- In operation since April 2015

**Euroasia interconnector**
- 2x1000 MW HVDC-VSC (4-terminals) linking: Attica-Crete-Cyprus-Israel
- Length: >1500 km – max sea depth ≈ 2700 m
- Estimated CAPEX: 5,3 b€
Energy exchanges and cross-border power transfer capacities

Yearly energy exchanges

- Yearly energy exchanges mainly for mutual support with exception of Morocco-Spain: **5,8 TWh** of energy import from Spain in 2014 based on bilateral contracts
- Net transfer capacity: **1,1 GW internal + 0,7 GW** between MO-SP

Demand decline in Europe: -150 TWh in 5 years, more than the total demand of Maghreb. Generation surplus across Europe

**Net Transfer Capacity:** **65 GW**

**14,5% of the internal demand**
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South-South and South-North interconnections: key drivers (1/2)

<table>
<thead>
<tr>
<th>Country</th>
<th>Yearly Load (TWh) 2014</th>
<th>Yearly Load (TWh) 2030</th>
<th>CAGR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>63.0</td>
<td>144.8</td>
<td>5.3%</td>
</tr>
<tr>
<td>Egypt</td>
<td>181.9</td>
<td>439.8</td>
<td>6.1%</td>
</tr>
<tr>
<td>Libya</td>
<td>43.0</td>
<td>100.6</td>
<td>5.8%</td>
</tr>
<tr>
<td>Morocco</td>
<td>35.9</td>
<td>74.4</td>
<td>5.0%</td>
</tr>
<tr>
<td>Tunisia</td>
<td>18.2</td>
<td>40.1</td>
<td>5.1%</td>
</tr>
<tr>
<td>TOTAL Demand</td>
<td>342.0</td>
<td>799.7</td>
<td>5.5%</td>
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Surge in power demand

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<th>CAGR (%)</th>
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<tr>
<td>Italy</td>
<td>47.6</td>
<td>125.8</td>
<td>7.8%</td>
</tr>
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</table>

- Impressive demand growth, both in energy and peak load
- Similar situation to what Italy and other Western European Countries experienced in the ‘60s

Priority: to achieve generation adequacy and a reliable transmission system
South-South and South-North interconnections: key drivers (2/2)

Targets of power generation from RES

Target as % of: total electricity and thermal energy (Lebanon); primary energy (Jordan), RES4MED elaboration. Investment figure for Tunisia (STEG data)

Priority: how to fit RES generation in the North African power systems?
South-North Integration: drivers

Drivers:

- Possibility of enhancing SoS for the SEMC
- Strong political commitment from the EU for energy integration with neighbouring region
  - Clear legislative and regulatory framework:
# Role of Interconnection for power exchanges: evolution in SEMC

## Years

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<td>1990 - now</td>
<td>- <strong>Reserve and mutual support</strong> facing large perturbations</td>
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<td>- <strong>Energy exchanges on the basis of pre-established contracts</strong> (usually long term contracts)</td>
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Borders: Spain-Morocco; Egypt-Jordan-Syria-Lebanon *(up to 2011)*
Vision for a decarbonisation of the EU-MENA region

**Short term: ..2025**

Trans-med links to favour RES integration in EU and enhance SoS in the NA

**Mid term: 2025-2035/40**

Progressive deployment of RES generation in NA. Trans-med links used for balancing RES intermittency

**Long term: 2035/40-2050**

Massive deployment of RES generation in the EU-MENA region. Massive power export towards Europe through trans-med e-highways

Western

Central

Eastern

MedGrid vision

D.i.i. vision
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Multilateral and bilateral studies: a long history (1/2)

2001-2003: 1st MedRing study

2012-2014: AFESD study

2003-2004: ELTAM

2009-2010: 2nd MedRing study

2012-2014: MedGrid study

2013: MedTSO master plan

2015-ongoing: MedTSO regional market study

2011-2013: D.i.i. study

* Public available
Multilateral and bilateral studies: a long history (2/2)

Bilateral studies for South-South and South-North integration

1: feasibility study completed in 2003
2: feasibility study completed in June 2004
3: feasibility study completed in Dec. 2005
4: feasibility study completed in February 2008

New ELTAM (2014/15) and WB (2015/16) studies on TII project
Common outcomes of the most recent studies: Transmission infrastructures

**East-West EHV corridor**

- 400 kV backbone from Morocco to Tunisia
- Construction of 400 kV north-south corridor in TN
- Back-to-back systems either at TN-LY or LY-EG border (or HVDC line EG-LY)
- Construction of a 500 kV AC line between EG-LY (or, alternatively) a HVDC line
Further outcomes of the most recent studies: Investments, benefits and energy exchanges

- Estimated investments in transmission lines (33,000 km) in the next 10 years: \(\approx 30 \) b€ out of which 20 b€ for internal lines and 10 b€ for interconnections, excluding North-South interconnections worth 2÷6 b€ additional investments (MedTSO Master Plan)

- Estimated investment in generation capacity (150 GW of which 15% RES): 220-250 b€ (MedTSO Master Plan)

- Benefits from integrated least cost optimisation of NG and G&T electric assets: 35 bUS$ in the time horizon 2013-2030 (AFESD)

- Potential for economic yearly energy exchanges within the interconnected Arab system: 125 TWh in 2030

- Definition of model for Inter-TSO compensation to be applied to Arab Countries fully compliant with the European model (AFESD)

- Financing study and implementation plan for all interconnections (AFESD)

Source: MedTSO
Outcomes of the most recent studies: World Bank and ELTAM studies

Objective of the study: to assess the economic profitability of the Tunisia-Italy Interconnection (TII) project up to 2030

- The TII project consists of a 600 MW +400 kV(*) HVDC submarine cable of about 200 km (sea depth around 750 m) between the Cap Bon peninsula (Tunisia) and Sicily (Italy)

- Preliminary CAPEX estimation: \( \approx 600 \text{ M€} \)

(*) Indicative value. Optimal DC voltage level not decided yet

Source: TII Project presentation to the EC held by TERNA- STEG on 29/2/2016
Outcomes of the most recent studies: World Bank and ELTAM studies

Main outcomes:

- Italy net exporter to Tunisia (>4 TWh/yr) along the whole study period
- Avoided RES generation curtailment in Italy: \( \approx 150 \text{-} 200 \text{ GWh/yr} \)
- Annual benefits from market analyses \( \approx 100 \text{ M€/yr} \) plus \( \approx 200 \text{ M€} \) of avoided investment in new generation in Tunisia
- Benefits also accrued to other European countries, notably France all over the study period and also Germany, Switzerland and Montenegro in 2020.
- TII economically attractive with PbP in the range between 6 and 7 years and an EIRR between 18.3% and 18.5%, depending on the assumptions on discount rate (4%÷8%) and lifecycle (25÷35 years).
- Project robust against a scenario with prolonged low commodity prices: PbP=10÷14 yr and EIRR≈12% with NG prices=7÷8 $/MBtu and coal prices=56÷69 $/t
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Existing barriers for South-South and South-North Integration

Existing Barriers

- Lack of shared rules for the Cross-Border electricity Trading prevents the full exploitation of the cross-border lines
- Subsidized electricity prices are a further barrier for the free trade of electricity among the SEMC
- Lack of capitals for investments in G&T assets
- Sometimes technical solutions decided only on a bilateral basis. In some cases this led to an adverse impact on the interconnected power pool
- (Lack of power surplus in the Southern Med countries...questionable)
- Insufficient implementation of transparency standards and establishment of information exchange
- ...
- The “political factor”

Need for robust technical & economic analyses aimed at identifying the best technical solutions and showing the project bankability

Could the Baltic Energy Market Interconnection Plan represent a good example for SEMC energy integration?
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Question 1:
✓ What are the main results of available studies on Mediterranean interconnections?

Question 2:
✓ What are the main obstacles to expanding electricity exchanges?

Question 3:
✓ What investments and actions are needed to overcome obstacles?
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Discussants:

- **Waleed Alsuraih**, Senior Energy Specialist, the World Bank
- **Frederick Azzopardi***, Chief Executive Officer (CEO), Enemalta, Malta
- **Ameur Bchir**, Chief Executive Officer (CEO), Société Tunisienne de l’Electricité et du Gaz (STEG), Tunisia
- **Paola Bresesti**, Managerial Adviser, PJ/Energy/Electricity Networks, European Investment Bank
- **Jürgen Kern**, Engineer, Institute of Engineering Thermodynamics, German Aerospace Center (DLR)
- **Kevin J. Sara**, Chairman and Chief Executive Officer, TuNur, Tunisia
- **Ali Zerouali**, Director of Cooperation and Partnership, Moroccan Agency for Solar Energy (MASEN), Morocco
CESI 60 years
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Milan • Berlin • Mannheim • Dubai • Abu Dhabi • Rio de Janeiro • Washington DC