Interconnection between Arab countries

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AUE

Enabling renewable energy in the electricity systems workshop
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Tunis
Arab Union of Electricity

• Date of Establishment: 1987
• Aims and Objectives:
  1- Improving and developing the generation, transmission and distribution of electrical energy in the Arab World.
  2- Developing, improving and coordinating the areas of interest of its members and strengthening the relationship among them.
• AUE includes 29 Active members from all Arab Countries.
AUE Activities

- **Publications:**
  - Dictionary of Electrical Terms of Electricity
  - Maps of Electrical Interconnection Networks in the Arab Countries
  - Arab Electricity Magazine
  - Annual Statistical Bulletin
  - Manual of Arab Experts in Electricity Sector.
  - Manual of Electricity Manufacturing Companies in the Arab Countries.

- **Studies**

- **Conferences, Seminars, and training courses.**
## Installed Capacity in Arab Countries in 2012 (GW)

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>25.7%</td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>35%</td>
</tr>
<tr>
<td>Combined Cycle</td>
<td>25.2%</td>
</tr>
<tr>
<td>Diesel</td>
<td>3.1%</td>
</tr>
<tr>
<td>Renewable</td>
<td>0.5%</td>
</tr>
<tr>
<td>Hydro</td>
<td>5%</td>
</tr>
<tr>
<td>Others</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

- **Total**: 213.5 GW
- **Growth Rate**: 5.7%
Average Growth Rate in Max. Demand During 2003-2012

G.R between 7-10%

It is considered to be high compared to international standards 1.2-2.4%.
Generated Energy in 2012
936 T.W.H

Growth Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>Steam</th>
<th>Gas Turbines</th>
<th>Combined Cycle</th>
<th>Diesel</th>
<th>Hydro</th>
<th>Solar &amp; Wind</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>6.7%</td>
<td>3.44%</td>
<td>0.34%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2011</td>
<td>5.8%</td>
<td>3.44%</td>
<td>0.34%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2010</td>
<td>7%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2009</td>
<td>8%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2008</td>
<td>6%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2007</td>
<td>8%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2006</td>
<td>10%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>2005</td>
<td>8%</td>
<td>2%</td>
<td>30%</td>
<td>8%</td>
<td>32%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Consumed Energy in 2012
755 T.W.H

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>43%</td>
</tr>
<tr>
<td>Industry</td>
<td>21%</td>
</tr>
<tr>
<td>Commercial</td>
<td>16%</td>
</tr>
<tr>
<td>Others</td>
<td>20%</td>
</tr>
</tbody>
</table>
Fuel Consumption in Electricity Sector
2003-2012
Additional Capacities During 2012-2020
240 GW
New combination of generation system in Arab countries by 2020.

- Steam Units increase by 3.4%
- Gas Units burning diesel Fuel decrease from 35% to 24.2%
- CC units burning NG increase from 25% to 31.5%
- Renewable energy participation increase from 0.5% to 4.1%
Remarks

✓ Average consumption per capita 2000 KWH / Year.

✓ It ranges between very high as in Qatar 15200 Kwh, Kuwait 14150 Kwh, and UAE 11650 Kwh, and very low as in Yemen 174 Kwh and Sudan 217 Kwh.

✓ Units burning HFO decrease each year while those burning NG increase.

✓ Maximum Demand growth rate was 7-10% during 2003-2012

✓ Expected forecast during 2012-2020 go little down between 6 -8%, which is still high compared to international standards 1.2-2.4%
Interconnection among Arab Countries

1. Existing interconnection
Eight Countries Interconnection

- **Libya**: 1998, 180MW, 220KV
- **Egypt**: 2008, 400KV
- **Syria**: 1998, 450MW, 400KV
- **Lebanon**: 2008, 400KV
- **Palestine**: 1998, 132KV, 10-15MW
- **Jordan**: 2009, 132KV, 10-15MW
- **Turkey**: 2001, 300MW, 400KV
- **Iraq**: 2003, 400KV
Remarks

- Exchanged Energy in 2013 was:
  - Egypt → Jordan 381 GWH
  - Jordan → Egypt 10.8 GWH
  - Jordan → Palestine 41.4 GWH

- Very little exchanged energy compared to the high investment costs.

- Main obstacles to utilize this interconnection efficiently are:
  ▶ Lack of enough generation capacity in most of the countries especially in summer.
  ▶ Weak interconnection between Egypt and Libya 220Kv, 180 Mw.
  ▶ No synchronize interconnection between Turkey and Syria.
  ▶ No interconnection between Syria – Iraq and Iraq - Turkey
Maghreb Interconnection

Morocco

Algeria
1980, 1984, 220 KV, 150 KV, 258 MW

Tunis

Libya
225 KV, still under testing
Remarks

• First interconnection in Maghreb Area was between Algeria and Tunis in 1953.

• Libya is not yet connected with Tunis. The ideal solution is to change interconnection from AC to DC.

• Exchange energy in 2013 between interconnected countries was:
  
  - Tunis ➔ Algeria 164 GWH.
  - Algeria ➔ Tunis 156 GWH
  - Algeria ➔ Morocco 177 GWH

• The only Arab Country interconnected with Europe is Morocco, via Spain. In 2013, Morocco imported 5374 GWH from Spain.
GCC interconnection

Stage 1: 7/2009. Saudi Arabia, Kuwait, Bahrain, Qatar.
Remarks

- First project in the area uses DC technology in interconnection.
- Internal networks were upgraded to match the technical requirements.
- Transmission lines are sufficient now, but it needs upgrade in the future for exporting energy to Europe through Saudi-Egypt interconnection.
- Import and export energy in 2013 was as previous years, almost by kind.
Imported and Exported Energy between GCC Countries
In 2013
Imported and Exported Energy between GCC Countries During 2009 - 2013
Planed interconnection
Egypt – Saudi Interconnection

500 kV DC, 3000MW, 2015
Recommendations

- Reinforcing and upgrading the existing Interconnection between Arab Countries, taking real steps towards interconnecting the non interconnected Countries.
- Necessary steps should be taken towards interconnecting the three Arab Regions (Mashreq, Maghreb and Gulf Countries)
- Interconnection between Turkey-Syria and Libya-Tunis is more likely to be by DC.
- An open electricity market between Arab Countries is essential to develop the exchange of electricity.
Thank you
MENA – Europe Interconnection

Existing

Spain

Morocco

Bulgaria

Turkey

2*400 KV 1996,2006

400 KV 2010

Imported Energy in 2011 = 4500 GWH

Greece

Energy in 2011 = 4500 GWH
Planned:
Libya-Italy

- A feasibility study for 1000 MW and 400 kV DC submarine cable, 520 km, was completed in May 2007.

Cable length: 520 Km
Cable depth: 550 M
A Feasibility study for an interconnection of a 500 MW, 400 kV DC submarine cable, 200 km, was finalized in February 2006.
Feasibility study was completed in June 2004.

A consortium of Algerian and foreign companies was established in November 2005 for the realization, exploitation and financing of the two undersea cables (Algeria – Italy via Sardinia; and Algeria-Spain)
MENA – Europe Interconnection

Cable length: 330 Km
Cable depth: 2000 M

Cable length: 250 Km
Cable depth: 1500-1900 M

Cable length: 200 Km
Cable depth: 670 M

Cable length: 520 Km
Cable depth: 550 M

2*400 KV 1996,2006
Remarks and Recommendations

• Lot of studies and meetings with very little progress towards interconnection between South and North banks of Mediterranean Sea.
• Meetings related to the MENA-Europe interconnection are represented by non decision maker personnel.
• Establishment of a Mediterranean Infrastructure Forum, or one of the existing forums to be responsible for follow up and expediting the interconnection, and coordination in planning, regulatory agreements, operation and all other related matters.
• Interconnection between Turkey- Syria and Libya- Tunis would be carried out on the basis of DC back- to-back system.
• Internal transmission networks and between countries need to be reinforced.
• Detailed visibility studies are needed for interconnection of Libya- Italy, Tunis-Italy, Algeria- Italy and Algeria- Spain.