TEIAS’ investments for ENTSO-E connection

Turkey-ENTSO-E Interface

05.05.2015

MEDELEC - 23rd Annual Meeting
• In parallel with official application by Greece to UCTE, the F/S of GR-TR interconnection line has been started for the parallel operation of Turkish Power System to UCTE network via Balkan Pool
• % 50 finance by TEN program
• Investment cost ~55 Million € (cost Benefit Analysis)

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2000</td>
<td>PPC S.A. Greece → application on behalf of TEAS Turkey for a synchronous parallel interconnection to UCTE (former ENTSO-E)</td>
</tr>
<tr>
<td>April 2000</td>
<td>UCTE Steering Committee decided for an evaluation</td>
</tr>
<tr>
<td>2005 – 2007</td>
<td>first study (Technical Analysis)</td>
</tr>
<tr>
<td>23 March 2006</td>
<td>UCTE set up the “Turkey Connection” Project Group</td>
</tr>
</tbody>
</table>
Complementary Studies for the Synchronisation of Turkish Power System with UCTE System

Rehabilitation of the Frequency Control Performance of Turkish Power System for Synchronous Operation with UCTE

1st Project

Complementary Studies for the Synchronisation of Turkish Power System with UCTE System

September 28, 2005 (Wednesday)

April 20, 2007 (Friday)
• **Project:**
  – “Complementary Studies for the Synchronous Interconnection the Electric Power System of Turkey to the UCTE Network”

• **Main Tasks:**
  – Static and dynamic security analyses
  – To see if synchronous connection of Turkish Power system to UCTE system is feasible

• **Budget:** 1.5 Million €

• **EC through the programme of Pre-accession Financial Assistance for Turkey as a 2003 Programme**
  – European Commission: 1,337,500 €
  – UCTE: 150,000 €
  – National Co-finance: 12,500 €

---

1st Project Conclusion

- Static Analysis
- Stability Analysis

**feasible**

- Existing inherent frequency control problem is resolved,
- Positive damping for the inter-area oscillations is assured
- Construction of System Protection Scheme at the interface
2. Project

- **Project:**
  - “Rehabilitation of the Frequency Control Performance of Turkish Power System for Synchronous Operation with UCTE”

- **Main Tasks:**
  - Re-design of power plant control and secondary control
  - Optimization of AVR/PSS settings, implementation of new SVC and STATCOM control
  - Setup of special protection schemes
  - Training, knowledge exchange

- **Budget:** 2.5 Million€

- **EC through the programme of Pre-accession Financial Assistance for Turkey as a 2007 Programme**
2nd Project Outcomes

- Survey of the power plants
- Design of governor control & parameter optimization
- Secondary Control optimization
- Training
- 10240 MW Hydro Rehabilitated/retuned
- 8 TPP Rehabilitated
- 14000 MW AVR&PSS retuned
- Installation of Special Protection Schemes
- Modifying SVC (±1150 MVAR)
- Installation of STATCOM (±50 MVAR)

SPS → ENTSO-E: Operation

- SPS,
  - in service since about 4 years,
  - supplied by GE Digital Energy
- Experience of several disturbances has always confirmed that SPS has correctly intervened
  - preventing separation from the ENTSO-E system and instability phenomena, and
  - minimizing propagation of disturbances to neighbouring countries.
### Milestones: Test Phase

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 December 2009</td>
<td>Agreement regarding interconnection</td>
</tr>
<tr>
<td>11-24 January 2010</td>
<td>Isolated Operation Test (Peak Load)</td>
</tr>
<tr>
<td>22 March-5 April 2010</td>
<td>Isolated Operation Test (Min. Load)</td>
</tr>
<tr>
<td>18 September 2010</td>
<td>Synchronous Parallel Operation Test Phase 1 – Synchronization Day</td>
</tr>
<tr>
<td>21 Feb.-7 March 2011</td>
<td>Synchronous Parallel Operation Test Phase 2</td>
</tr>
<tr>
<td>1 June 2011 – April 2014</td>
<td>Synchronous Parallel Operation Test Phase 3</td>
</tr>
<tr>
<td>9 &amp; 24 April 2014</td>
<td>Decision for Permanent Synchronous Operation</td>
</tr>
<tr>
<td>3 March 2015</td>
<td>LTA sign &amp; Start of the Permanent Synchronous Operation</td>
</tr>
</tbody>
</table>

**In RG CE Plenary meeting on 4 September 2013, PG Turkey presented its final report:**

“PG considers that the connection of Turkish PS is safe for CE synchronous area system and proposes to conclude that the trial operation is successful under the condition of:

- completion of the works related to the installation of the SPSs in two areas of Turkey and
- the completion of first STATCOM installations at South East of Turkey by the end of the year 2013, to mitigate the irrigation problem.
- Further work shall be also done for the implementation of on line security analysis (N-1 contingencies), and
- improvements of telecom backbone.

**these 4 conditions are already fulfilled.** PG Turkey will continue observing the efficiency of the implemented measures. Regarding the irrigation problem, 2x12.5 and 25 MVAr STATCOMs are installed at SE Turkey
• Decrease of primary frequency control reserve
• More stable frequency
• After signing the Long Term Agreement with ENTSO-E;
  – have a permanent synchronous connection to ENTSO RG CE
• Synchronous connection to ENTSO-E promotes the electricity exchange possibilities
• Access to the European Internal Market

<table>
<thead>
<tr>
<th>Year</th>
<th>New OHL in 380 kV (km)</th>
<th>New OHL in 154 kV (km)</th>
<th>New Transformer Capacity (MVA)</th>
<th>Investment Budget (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>202.7</td>
<td>277.8</td>
<td>4196</td>
<td>402,308,844</td>
</tr>
<tr>
<td>2010</td>
<td>936.3</td>
<td>676.1</td>
<td>6180</td>
<td>249,462,402</td>
</tr>
<tr>
<td>2011</td>
<td>419.2</td>
<td>270.6</td>
<td>4806</td>
<td>318,037,425</td>
</tr>
<tr>
<td>2012</td>
<td>365.3</td>
<td>602.4</td>
<td>8188</td>
<td>397,748,134</td>
</tr>
<tr>
<td>2013</td>
<td>464.6</td>
<td>461.7</td>
<td>9390</td>
<td>611,145,064</td>
</tr>
<tr>
<td>2014</td>
<td>874.5</td>
<td>1189.5</td>
<td>4344</td>
<td>468,264,442</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,263</td>
<td>2,289</td>
<td>37,104</td>
<td>2,446,966,311</td>
</tr>
</tbody>
</table>
Thank You...

Doruk ÖZKÖK
doruk.ozkok@teias.gov.tr