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RECONNECTION OF TWO UCTE ZONES AS A HISTORIC MILESTONE IN THE EUROPEAN »ELECTRICAL« HISTORY

The successful reconnection of the first and second UCTE synchronous zones was completed on 10 October, 2004 after years of preparation at UCTE level as well as at the level of UCTE member companies and all electricity systems of the countries involved. The size of the two UCTE synchronous zones, the character of their interface extending from the Adriatic to the Carpathian Mountains in Ukraine and the scope of work, made the reconnection process one of the largest and most complex projects and challenges in the history of UCTE.



The UCTE system divided in two synchronous zones in 1991

The UC(P)TE synchronous system was split in autumn 1991 into two zones due to the war in former Yugoslavia that resulted in the destruction of the key 400kV substations (Ernestinovo and Konjsko) and the associated transmission lines in Croatia and Bosnia & Herzegovina (Mostar).

From 1991 on, major enlargements of the UCTE areas took place.

In the 1st zone, the CENTREL members from the Czech Republic, Hungary, Poland and Slovakia synchronized in 1995, followed in 1997 by the system of Morocco, later on joint also by Algeria and Tunisia and, in 2002, synchronisation of the Western part of Ukraine, the so-called »Burshtyn Island«.

In the 2nd UCTE synchronous zone, the Romanian and Bulgarian systems were synchronized in mid 90s.

Only at the beginning of this decade, after political and security preconditions were met, substantial preparations for the reconnection of UCTE zones could start.

The reconnection process was defined as a three-step procedure:

- a) the creation of missing infrastructure (as fundamental pre-requisite, but in itself not sufficient),
- b) the re-synchronization program (for the reconnection sequence itself),
- c) the measures after the physical reconnection.

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Reinforcements of the transmission grid

After a Memorandum of Understanding was signed in 2001 by UCTE, HEP (Croatia), ZEK (Bosnia-Herzegovina) and EPS (FR Yugoslavia – at that time) with the aim to facilitate activities necessary for the reconnection, the financing for the reconstruction of the crucial transmission facilities was secured in 2002: in Croatia, through domestic sources, in Bosnia and Herzegovina by International Financial Institutions.

The reconnection process was made possible by the (in fact) new construction of the 400/110kV Ernestinovo substation with the adjoining transmission lines, the construction of the 400/220/110kV Žerjavinec substation by HEP in Croatia and the reconstruction of key transmission facilities by ZEK in Bosnia and Herzegovina such as the 400/220/110kV Mostar substation and a large part of the country's 400kV grid together with the reconstruction of several 220kV lines between both countries.

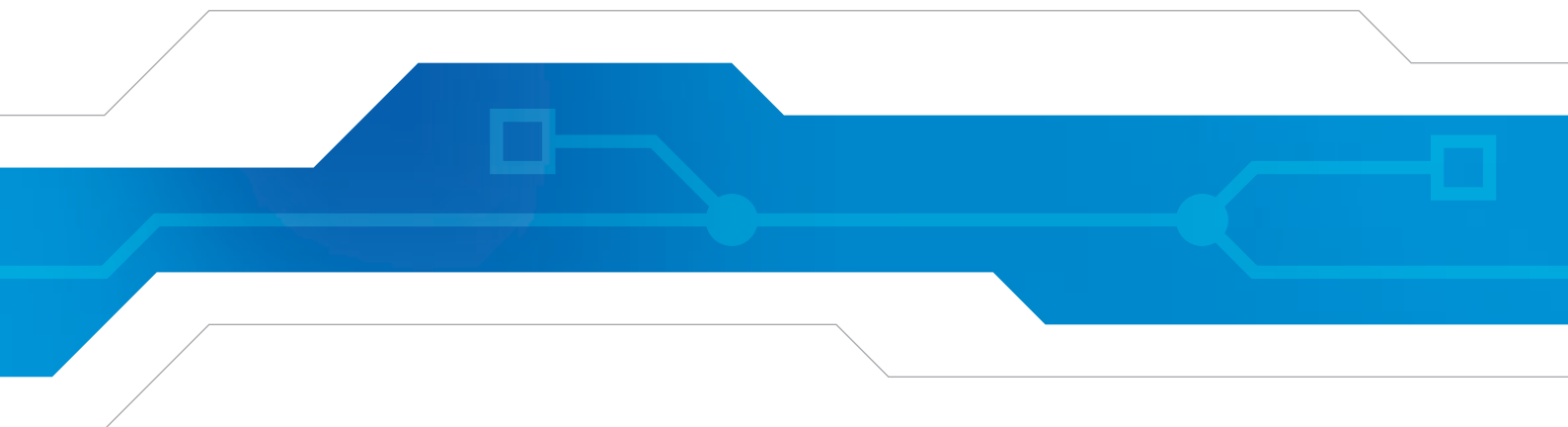
After the completion of all investment projects in August 2004, the whole electricity system of Bosnia and Herzegovina was reintegrated into the 1st UCTE synchronous zone.

Thus a 400kV ring, which strengthens the Croatian system and the system of Bosnia and Herzegovina increasing the security of electricity supply, was closed comprising the nodes Ernestinovo – Žerjavinec – Tumbri – Melina – Velebit – Konjsko (in Croatia) and Mostar – Sarajevo 10 – Tuzla – Ugljevik (in Bosnia and Herzegovina).

The main preconditions for the reconnection of both UCTE zones were herewith fulfilled.

Finally, in late September 2004, another precondition – the harmonization of phase sequences on the interfaces of the Croatian electricity system was successfully carried out by HEP by rearranging the physical couplings on towers. Due to the close co-operation with neighbouring systems such as ELES and MAVIR, and other TSOs and partners, and thanks to the careful implementation of detailed programmes and the effective co-ordination, grid users were not affected; the island operation of the grids of Croatia and Bosnia-Herzegovina lasted only 4 seconds.

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UCTE Executive Team for North-South Resynchronization (UCTE ET)

At its meeting in Zagreb on 12 March 2002, the UCTE Steering Committee (UCTE SC) established the UCTE Executive Team for North-South Re-synchronization (UCTE ET) that was charged to act as »project manager« of the reconnection process.

The UCTE ET was composed of representatives of TSOs along the whole interface between both zones and from other countries involved, namely Bosnia-Herzegovina, Bulgaria, Croatia, FYR of Macedonia, Greece, Hungary, Romania, Slovak Republic, Slovenia, Serbia and Montenegro and Ukraine. Both UCTE Co-ordination Centres (RWE Transportnetz Strom in Brauweiler, Germany, and ETRANS in Laufenburg, Switzerland) were also represented in the UCTE ET.

Mr. Jirí Feist (CEPS, Czech Republic) and Mr. Ivica Toljan (HEP, Croatia) were appointed co-convenors. After Mr. Feist left CEPS and UCTE at the end of July 2004, Mr. Milan Jevšenak (ELES, Slovenia) was appointed new co-convenor. Throughout the course of the work of UCTE ET, Mr. Damjan Meimorec (HEP, Croatia) acted as secretary of the ET.

The UCTE ET steered the complex reconnection process through monitoring the preparation activities and proposing the necessary requirements to UCTE SC. Among the co-ordination activities of the ET were the preparation, harmonization and testing of electricity and telecommunication facilities, organizational measures for the necessary infrastructure to manage the new control blocks of UCTE, as well as the organization of necessary calculations and analyses in order to avoid negative impacts on the entire UCTE system. The minimum grid configuration needed for re-synchronization was defined and the design of control blocks for the period after re-synchronization was approved.

The progress made in (re)construction of the grid infrastructure affecting the re-synchronization was monitored by standardised inventory reports on a regular basis and by progress reports.

In conclusion, the Multilateral Resynchronization Program (MRP) summarizing all activities and their results, was prepared by the UCTE ET and signed by its members. After all previously agreed mandatory technical and organizational conditions (such as functionality and readiness of control blocks, measures to preserve steady-state and dynamic stability of the whole reconnected system, etc.) were fulfilled in mid-September 2004, the Steering Committee of UCTE gave its final approval to the proposed date of resynchronization and the sequence of switching, as well as to the complete MRP at its meeting in Sarajevo on 23 September 2004. (see figure 1)

10 October 2004: resynchronisation

The final phase of the major technical challenge, which was one of the most significant electricity-related events in Europe in the recent years, took place on 10 October 2004.

The resynchronisation procedure was co-ordinated by Mr. Toljan and Mr. Jevšenak from the HEP premises in Zagreb, in direct communication with national co-ordinators along the resynchronisation interface (Bosnia-Herzegovina, Croatia, Hungary, Montenegro, Romania, Serbia and Ukraine), and with contact persons of control blocks in the 2nd UCTE synchronous zone (JIEL, Bulgaria and Greece).

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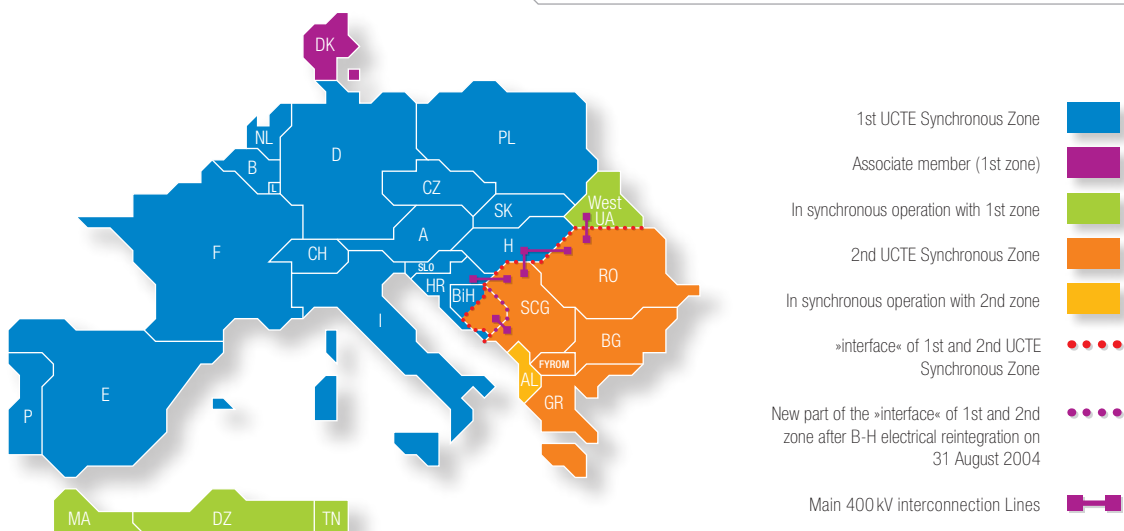


Figure 1: Resynchronization interface with main 400 kV lines

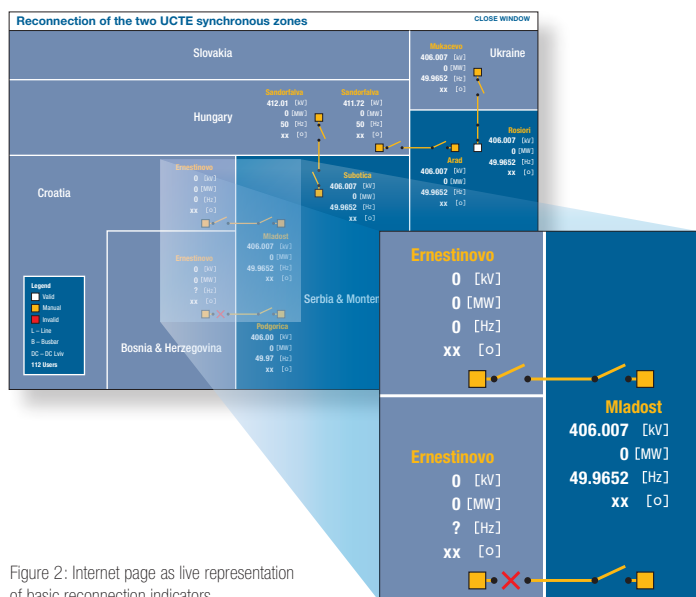


Figure 2: Internet page as live representation of basic reconnection indicators

>>> In order to have a visual representation of all relevant data from the main (400kV) lines across the resynchronisation interface also for all TSOs involved and the interested UCTE audience, a dedicated web site with restricted access was put in place by HEP using data (voltages, active power and frequency values, as well as the status of circuit-breakers in all key facilities) collected from the SCADA and IT systems of the respective TSOs. (see figure 2)

After performing the prescribed preparatory steps aimed at fulfilling the conditions for switching, the physical re-synchronization of the 2nd UCTE synchronous zone to the main UCTE grid took place at 9:34 (Central European Summer Time), by switching the circuit-breaker of the Sandorfalva line in the Arad substation (Romania).

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>>> Following the necessary steps of confirmation and fulfilling all the conditions, the line Sandorfalva-Subotica was switched on at 9:41 by closing the circuit-breaker of the Subotica line in the Sandorfalva substation (Hungary). It was observed that the power oscillations were more significant than on the first line, though only transiently (as expected according to the preliminary steady-state analysis) so that the continuation of the switching sequence was not endangered.

The Trebinje-Podgorica line followed already at 9:58 by closing of the circuit-breaker of the Podgorica line (Serbia and Montenegro) in the substation Trebinje (Bosnia-Herzegovina). This was considered to be the most critical part of the sequence due to the significant voltage difference between Podgorica and the Trebinje substation during a longer period before switching. But thanks to well co-ordinated series of operational activities on both sides including the help of neighbouring TSOs, this voltage difference was reduced in a rather short time without a negative influence upon other conditions required for switching (such as angle difference).

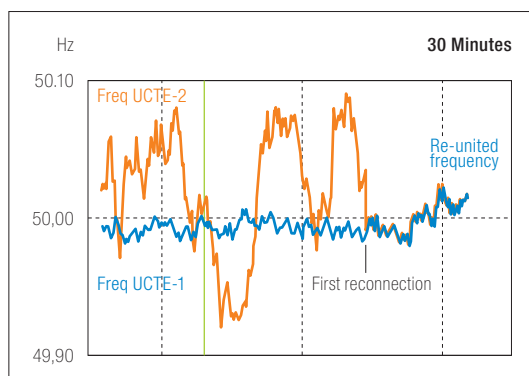


Figure 3: Two UCTE frequencies merging into one on 10 October 2004 at 9:34 (according to ETRANS measurements in Switzerland and in Greece)

Afterwards, at 10:07, the line Mukachevo-Rosiori was switched on by closing the circuit-breaker of the Mukachevo (Ukraine) line in the Rosiori substation (Romania).

The switching sequence of the five 400kV lines ended at 10:20 with the line Ernestinovo-Mladost that was switched on by closing the circuit-breaker of the Mladost line (Serbia and Montenegro) in the Ernestinovo substation (Croatia). As expected (according to the load-flow analysis specifying the switching sequence) major power flows (300 – 400MW) were observed on this line as a consequence of parallel flows from both former synchronous zones. The same effect, but to a smaller extent, was noticed over other closed 400kV lines bridging the interface.

The last of three lines of lower voltages (220 and 110kV) connecting Bosnia-Herzegovina and Serbia was successfully switched on at 10:58, taking over some of the parallel flows on the southern part of the former resynchronisation interface from the Trebinje-Podgorica line.

The reconnection was accomplished according to the prepared time schedule of the Multilateral Resynchronisation Programme in an atmosphere of professional co-operation amongst the representatives of the ten countries directly involved. Full trial operation of the reconnected system started from 11 a.m. (Central European Summer Time) on 10 October 2004. <<<



Trial operation after reconnection

With the UCTE reconnection, the whole European mainland became a single UCTE synchronous area, the second largest in the world. The completion of the UCTE reconnection process had an impact on operational conditions at regional and European level (whole UCTE) to the extent expected.

Nevertheless, during trial operation for obvious security reasons, electricity trading was not allowed across the former interface until early November 2004. Based on the successful results of the trial operation, a gradual increase of commercial electricity exchanges across the former interface (from the former 2nd zone to the 1st zone only) was recommended in order to monitor the global system response to the new flow patterns. The following capacities were allowed since no unforeseen operational events occurred in the meantime: 30% of the indicative and preliminary NTC values (according to UCTE calculations and as published on the ETSO website www.etso-net.org) for November, 60% for December, and from 1st January 2005, full NTC values (based on harmonized technical calculations).

Since the mission of UCTE ET was successfully completed, the Steering Committee decided to dissolve the UCTE ET at the meeting held in Sofia on 25 November 2004.

Further monitoring of the developments on and around the former interface in the next months (especially the new flow patterns) has become a normal UCTE operational issue and was therefore entrusted to the WG Operations and Security, more specifically to its SG TSO-Forum.

The final assessment from a stability point of view, particularly regarding the damping behaviour and the conclusion about possible further needs of PSS optimisation in the whole former 2nd zone will be made after one year of operation, based on WAMS monitoring.<<<

Technical conditions for the European electricity market: UCTE contribution to the Athens process

The reconnection has a Europe-wide impact to the whole electricity sector beyond transmission, as it physically integrated regional electricity markets in South-East Europe into the Internal Electricity Market of the European Union. This fact also influences the development of further electricity infrastructure projects.

From the very beginning of the Athens Process (in South-East Europe), the role of UCTE has been recognized as a provider of basic technical preconditions for a gradual establishment of a single European electricity market and for the further development of the economies of the countries within the UCTE system, both EU and Non-EU members.

The Athens Forum especially acknowledged the substantial improvements achieved in terms of regional infrastructures and the fact that operational agreements in all relevant control blocks were signed. <<<