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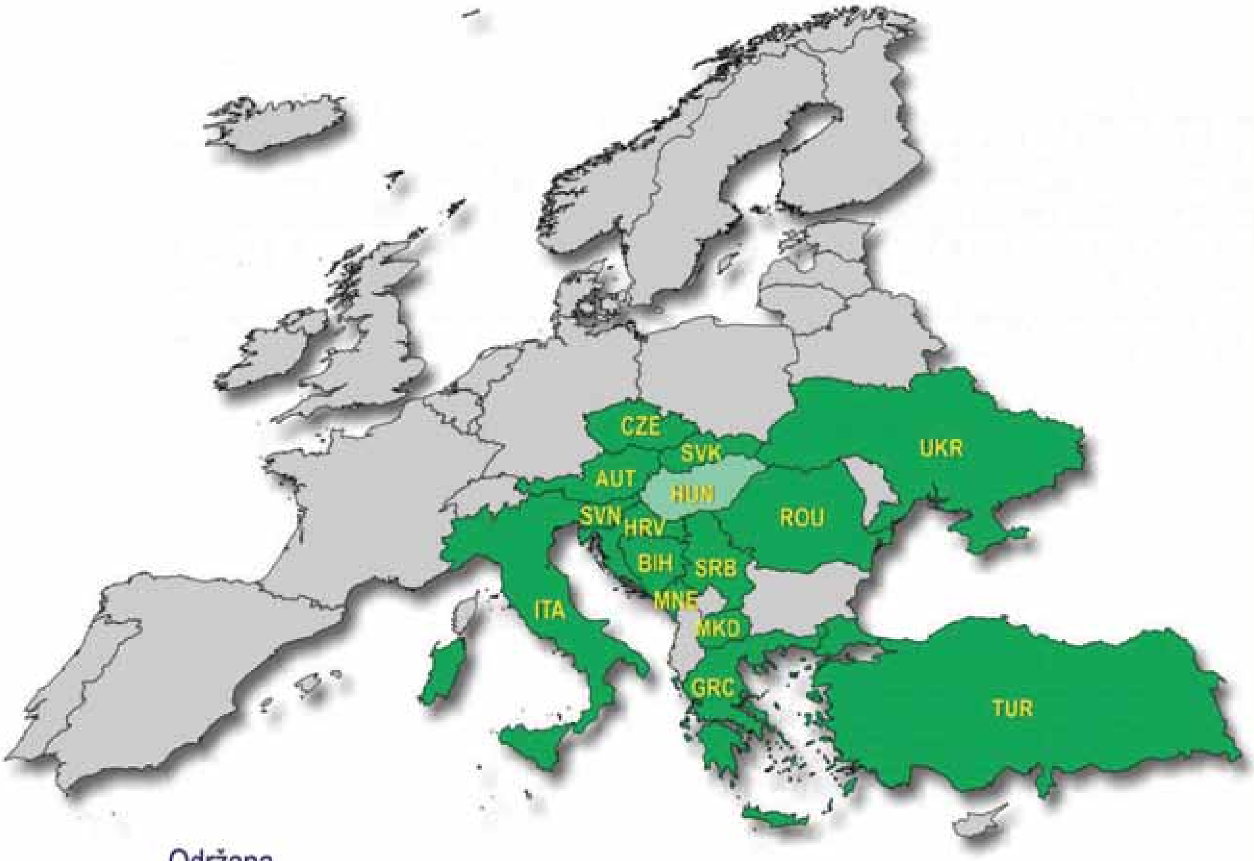

Održana
Prva konferencija
Regionalne CIGRE za
Jugoistočnu Evropu **SEERC**

20 godina Nacionalnog komiteta CIRED Srbija

10. jubilarno savetovanje
o elektrodistributivnim
mrežama Srbije

SERBIA СРБИЈА

Časopis udruženja


УСМЕРАВАМО


ГРАДИМО


ЧУВАМО


СПАЈАМО


ПОКРЕЋЕМО


ПОВЕЗУЈЕМО


НАПРЕДУЈЕМО


ВОДИМО

SADRŽAJ

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Srpski nacionalni komitet CIGRE,
Beograd, Knez Miloša 11
Srpski nacionalni komitet CIRED,
Novi Sad, Bulevar oslobođenja 100

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REČ PREDSEDNIKA CIGRE Srbija & CIRED Srbija

Poštovani čitaoci, uz malo kašnjenje, nastavljamo sa izdavanjem novog periodičnog časopisa nacionalnih komiteta CIGRE Srbija i CIRED Srbija pod nazivom $\mathbf{CI^{G}RE_{D}}$.

Ovaj broj donosi izveštaje sa održanih skupova u prvoj polovini 2016. godine, kao i najavu važnijih skupova CIGRE Srbija i CIRED Srbija u drugoj polovini 2016. godine.

Od održanih skupova, u ovom broju časopisa najviše pažnje posvećeno je tek održanoj Prvoj konferenciji Regionalne CIGRE – SEERC (Portorož, 7. – 8. jun 2016). Od međunarodnih skupova u drugoj polovini 2016. godine svakako je najznačajnije 46. savetovanje CIGRE PARIS (Pariz, 21. – 26. avgust 2016), a važno je spomenuti pripreme za 10. jubilarno savetovanje CIRED Srbija (Vrnjačka Banja, 26. – 30. septembar 2016) i 17. simpozijum CIGRE Srbija – *Upravljanje i telekomunikacije u EES* (Vršac, 16. – 19. oktobar 2016).

Reakcije stručne javnosti Srbije na prva dva broja časopisa $\mathbf{CI^{G}RE_{D}}$ su vrlo dobre.

I ovog puta, pored niza informacija iz oblasti rada i delovanja nacionalnih komiteta CIGRE Srbija i CIRED Srbija, uvrštena su dva stručna rada srpskih autora prezentovana na Prvoj konferenciji Regionalne CIGRE – SEERC i 46. savetovanju međunarodne CIGRE u Parizu. Međutim, to nije dovoljno za stručnu javnost, jer se u Srbiji već više godina oseća nedostatak „pravog" stručnog časopisa za oblast elektroenergetike (kao što je bio časopis *Elektroprivreda*). Na tu manjkavost je ukazao i Izvršni odbor CIRED Srbija, sa idejom da naš časopis $\mathbf{CI^{G}RE_{D}}$ preraste stručni časopis ili da se pokrene inicijativa kod nadležnih Republičkih organa i Javnih preduzeća Elektroprivreda Srbije i Elektromreža Srbije da se ponovo pokrene izdavanje posebnog stručnog časopisa. Uređivački odbor časopisa $\mathbf{CI^{G}RE_{D}}$ (u proširenom sastavu) je razmatrao navedene sugestije i zaključio da časopis $\mathbf{CI^{G}RE_{D}}$ ostane u dosadašnjoj formi, s tim da strukovna udruženja CIGRE Srbija i CIRED Srbija pokrenu inicijativu i podrže izdavanje posebnog stručnog časopisa, kao na primer *Elektroprivreda*.

Pored navedenog, Uređivački odbor časopisa $\mathbf{CI^{G}RE_{D}}$ doneo je odluku da se koncept časopisa dopuni i objavljivanjem priloga o obrazovnim institucijama, naučno-istraživačkim institutima, javnim preduzećima i svim drugim privrednim subjektima, da iskoriste časopis za prezentaciju svojih referenci, proizvodnih programa, planova razvoja, i sl. Ovim putem želimo da pozovemo poslovodstva svih tih ustanova i kompanija da nam se jave.

Nadamo se da će čitaoci trećeg broja časopisa $\mathbf{CI^{G}RE_{D}}$ biti upoznati sa našim aktivnostima na domaćem i međunarodnom planu na zadovoljavajući način. Očekujemo Vašu pomoć kako bi zajedno ostvarili ciljeve dve najveće asocijacije u oblasti elektroenergetike u Republici Srbiji – CIGRE Srbija i CIRED Srbija.

**Predsednik CIGRE Srbija,
mr Gojko Dotlić**

**Predsednik CIRED Srbija,
dr Zoran Simendić**

Prva konferencija Regionalne CIGRE za Jugoistočnu Evropu – SEERC

(Portorož – Slovenija, 07.- 08. jun 2016)

U organizaciji Nacionalnog komiteta CIGRE Slovenija, od 7. do 8. juna 2016. godine u Kongresnom centru hotela „Bernardin“ u Portorožu (Slovenija), održana je Prva konferencija Regionalne CIGRE za Jugoistočnu Evropu – SEERC. Konferencija je okupila učesnike iz 14 Nacionalnih komiteta CIGRE – članica SEERC (Austrije, BiH, Hrvatske, Češke Republike i Slovačke, Grčke, Mađarske, Italije, Makedonije, Crne Gore, Rumunije, Slovenije, Ukrajine, Turske i Srbije). Zvanično je bilo registrovano oko 250 učesnika.

Prvog dana rada konferencije održane su sledeće sesije:

- Svečano otvaranje
- Akademski forum
- Prezentacije EES zemalja članica SEERC

Na žalost, iako smo bili pozvani, nismo učestvovali u prezentaciji nacionalnih EES prvog dana konferencije.

Drugi konferencijski dan je u celosti bio posvećen stručnim sesijama koje su se odvijale po unapred definisanim temama (*en*. topics):

Topic 1: Energy and Environmental policy in Region

Topic 2: Submarine cables issues in Region

Topic 3: Regional Energy Market Aspects

Topic 4: Innovation in electricity infrastructure of the Region

Paralelno sa stručnim sesijama bile su organizovane tzv. poster prezentacije odabranih radova – interesantnih sa aspekta regionalne saradnje i razvoja.

CIGRE Srbija je bila relativno skromno zastupljena na ovoj Konferenciji. Pored rada u organizacionim telima konferencije, predstavnici CIGRE Srbija su se istakli u sledećim aktivnostima:

- Izvestioc o Univerzitetu u Beogradu na Akademskom forumu bio je prof. dr Zlatan Stojković sa ETF Beograd, predsednik STK C4 CIGRE Srbija;
- Predsedavajući za sesiju "Regional Market issues" bio je mr Nenad Stefanović iz ARES, predsednik STK C5 CIGRE Srbija;

Prezentovana su 4 stručna rada iz Srbije u okviru 4 sesije po odabranim preferencijalnim temama:

1. *Security principles for ICT infrastructure in a Power Utility Smart Grid* (Bojan Milinković, Jasmina Mandić-Lukić, Srđan Latinović)
2. *Implementation of Reserve Trading in SMM ENTSO-E Control Block* (Goran Jakupović, Ninel Čukalevski, Nikola Obradović, Duško Aničić)
3. *Design and Implementation of the South East European Power Exchange -SEEPEX* (M. Mladenović, D. Stojčevski, A. Petković)
4. *Communication solutions for Smart Distribution network - Public versus private infrastructure* (Jasmina Mandić-Lukić, Bojan Milinković, Željko Vasiljević, Nenad Simić)

Prezentovana su 2 stručna rada iz Srbije u okviru „poster" prezentacija radova, i to:

1. *Information Security in Electric Power Utilities' Environment* (Radoslav Raković, Jasmina Mandić Lukić, Nina Čukić)
2. *Solutions for Alternative Route of the Teleprotection Communication Channel* (Vladimir Čelebić, Anka Kabović, Milenko Kabović, Jovanka Gajica, Iva Salom)

Po održavanju stručnih sesija, Tehnički savetodavni komitet i predsedavjući na stručnim sesijama su izabrali najzapaženije radove i radove koji će se ponuditi za štampanje u stručnom časopisu *CIGRE Scienece & Engineering*.

Za najzapaženije radove po temama proglašeni su radovi :

Topic 1: Željko Tomšić, Ivan Rajšl, Matea Filipović (Croatia), "*Low Carbon Development Strategy for Croatian Electricity Sector Until year 2070*"

Topic 2: J. Kabouris, K. Tsirekis, A. Georgopoulos, I. Aravanis (Greece), "*The Interconnection of the Cycladic Islands: A Major Innovative Transmission Project for the Greek EPS*"

Topic 3: D. Martinčić (Montenegro), D. Međumorec (Croatia), A. Mijušković (Montenegro), "*Regionally coordinated auctions of cross-border transmission capacities between South East European Transmission System Operators*"

Topic 4: Klemens Reich, Michael Leonhardsberger, Herbert Lugschitz (Austria), "*Test-run for uprating of Overhead Lines using innovative Technologies at APG*"

Radovi odabrani za štampanje u stručnom časpoisu *CIGRE Scienece & Engineering su :*

Topic 1: Gorazd Bone, Rafael Mihalič (Slovenia), "*A dynamical equivalent for the electric power system*"

Topic 2: Milutin Ostojić, Martin Ćalasan (Montenegro), "*Magnetic Field of the Bipolar HVDC Cable Italy-Montenegro in the See and in the Land Section*"

Topic 3: C. Todem, A. Kaiser, V. Wiedner, H. Wornig (Austria), "*T European network codes - Bidding Zone Review Impacts on the SEE region resulting from a Austrian-German market split*"

Guido Guida, Mauro Caprabianca, Federico Quaglia, Luca Luzi, Carlo Bruno, Marta Maria Emolumento, Matteo Simone Stori (Italy), "*Innovative tool for the outages plan optimization in the Italian Transmission Network*"

Topic 4: Massimo Muggiasca (Italy), "*Unsymmetrical Spacer Damper designed to control the sub span oscillation of a conductor bundle*"

George Messinis, Aris Dimeas, Vasilis Rogkakos, Kostas Andreadis, Iraklis Menegatos, Nikos Hatziargyriou (Greece), "*Utilizing Smart Meter Data for Electricity Fraud Detection*"

Na kraju konferencije, pored svečanog uručivanja zahvalnica za najzapaženije radove, izvršena je primopredaja funkcije predsednika Regionalne CIGRE za Jugoistočnu Evropu – SEERC u narednom dvogodišnjem mandatu 2016-2018. Naime, po osnivačkom dokumentu ustanovljen je redosled predsedavanja Nacionalnih komiteta po abecednom redu (na engleskom). Tako je mesto predsedavanja u narednom periodu 2016-2018 trebao da preuzme Nacionalni komitet CIGRE Turske, ali su zbog nedovoljnog iskustva u tome (osnovani su tek 2015. godine), to mesto prepustili sledećem, tj. Nacionalnom komitetu Ukrajine.

Yuriy Bondarenko, potpresednik i generalni sekretar Nacionalnog komiteta CIGRE Ukrajina – novi predsednik SEERC

Yuriy Bondarenko, je član međunarodne CIGRE od 1994. godine. Jedan je od osnivača Nacionalnog komiteta CIGRE Ukrajina, a od 2004. godine je na funkciji potpresednika i generalnog sekretara CIGRE Ukrajina. Od 2007. godine je član Administrativnog saveta CIGRE Pariz ispred svog Nacionalnog komiteta. Učestvovao je u osnivanju Regionalne CIGRE za Jugoistočnu Evropu (SEERC) 2013. godine, gde je član Upravnog odbora, član Tehničkog savetodavnog komiteta i Predsedavajući radne grupe RWG-04: *Technical and economical features of Hydro Pumped storage power plants (HPSPPs) in power systems*. Dobitnik je plakete istaknutog člana (*en*. Distinguish Member) međunarodne CIGRE za 2014. godinu.

Yuriy Bondarenko se trenutno nalazi na poziciji Generalnog direktora *Science and Technology Company* ***ENPASELECTRO*** gde je uključen u niz projekata vezanih za EES Ukrajine.

Inače, pored aktivnosti u organizacijama CIGRE, Yuriy Bondarenko je član Ukrajinske akademije tehnoloških nauka, član Ukrajinske akademije za nauku, član IEEE instituta, predsednik Državne komisije za ispite iz oblasti elektro inženjerstva i elektro tehnologija pri Nacionalnom tehničkom univerzitetu *Kyiev Polytechnical Institute*, član Izdavačkih odbora časopisa *Električne mreže i sistemi* i *Hidroenergija*. Autor je više od 30 stručnih radova. Dobitnik je navišeg državnog priznanja iz oblasti nauke i tehnike za doprinos razvoju EES Ukrajine.

First South East European
Regional CIGRÉ Conference
Portoroz, Slovenia, 7—8 June 2016

SEERC

Prva regionalna konferencija za jugoistočnu Evropu
Akademski forum

Univerzitet u Beogradu
Elektrotehnički fakultet

Dr. Zlatan Stojković, redovni profesor

Na nedavno održanoj Prvoj regionalnoj konferenciji CIGRE posebna sesija je bila posvećena akademskom forumu sa ciljem prikaza aktivnosti univerziteta iz regiona na sprovođenju Bolonjskog procesa i njegovom poboljšanju. Izabrani su predstavnici univerziteta u Ljubljani, Rimu, Beogradu i Kijevu sa zadatkom da prikažu koncepciju nastave iz oblasti elektrotehnike – elektroenergetike i daju odgovor u vezi spremnosti ovih univerziteta da školuju inženjere ove oblasti za 21. vek. Na samoj konferenciji izabranim predstavnicima su pridruženi i predstavnici univerziteta u Sankt Peterburgu i Istanbulu. U nastavku je dat kratak prikaz izlaganja predstavnika Elektrotehničkog fakulteta Univerziteta u Beogradu.

1. O Univerzitetu u Beogradu

Univerzitet u Beogradu predstavlja najstariju i najveću instituciju visokog obrazovanja u Republici Srbiji. Osnovan je 1808. godine i u njegovom sastavu se trenutno nalaze 31 fakultet i 11 instituta. Na Univerzitetu je trenutno angažovano 8500 nastavnika i saradnika koji učestvuju u edukovanju oko 85000 studenata. Od 2012. godine Univerzitet u Beogradu se nalazi na prestižnoj Šangajskoj listi univerziteta, čime spada u prvih 400 univerziteta u svetu odnosno u 2% od ukupnog broja svih univerziteta.

2. O Elektrotehničkom fakultetu

Elektrotehnički fakultet Univerziteta u Beogradu je osnovan 1948. godine i danas ga čine 7 odseka, 42 laboratorije, 136 nastavnika, 46 saradnika i 4423 studenta. Na Fakultetu postoje dva studijska programa

- Elektrotehnika i računarstvo,
- Softversko inženjerstvo (od 2006. godine).

Prema zvaničnim podacima za 2015. godinu, na Fakultet su upisana 672 studenta, od čega na studijskom programu Elektrotehnika i računarstvo 548 (400 na budžetu, 148 na samofinansiranju), dok su na studijskom programu Softversko inženjerstvo upisana 124 studenta. Više podataka o Fakultetu je dato u [1].

Prva godina studija na studijskom programu Elektrotehnika i računarstvo je zajednička. Studenti se usmeravaju u trećem semestru i, prema podacima iz 2015. godine, raspodela studenata po pojedinim odsecima bila je sledeća

- Računarska tehnika i informatika 120,
- Energetika 90,
- Elektronika 52,
- Signali i sistemi 55,
- Telekomunikacije i informacione tehnologije 79,
- Fizička elektronika 34.

Na studijskom programu Softversko inženjerstvo je registrovano 109 studenata u trećem semestru. Procentulana raspodela studenata u trećem semestru prikazana je na Slici 1.

3. O Odseku za energetiku

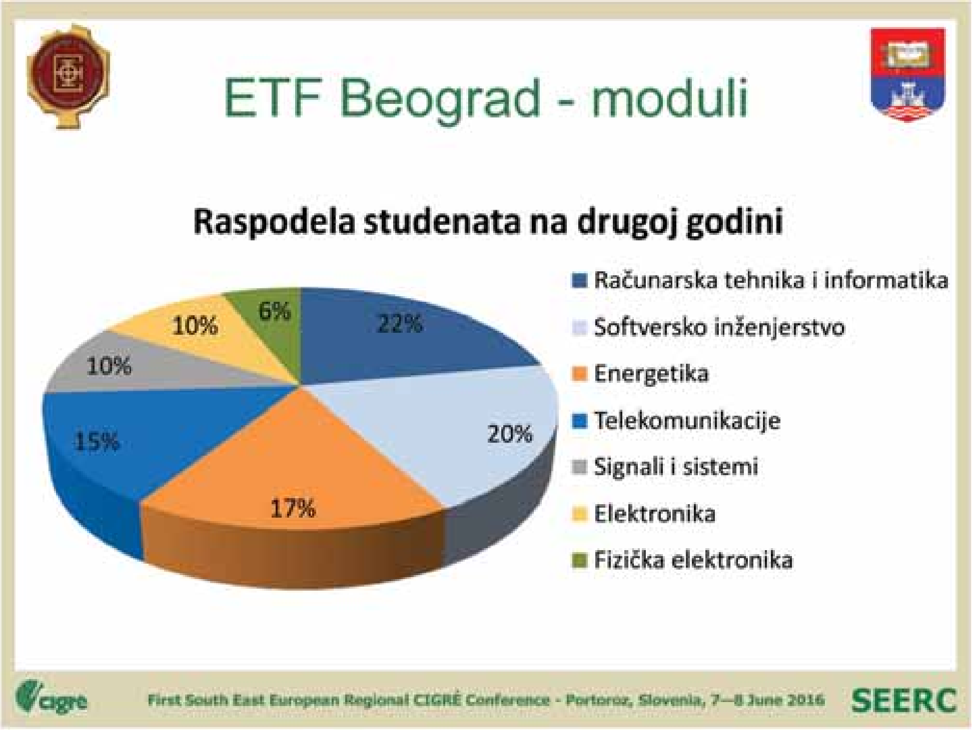
Odsek za energetiku Elektrotehničkog fakulteta Univerziteta u Beogradu predstavljaju dve katedre

- Katedra za elektroenergetske sisteme,
- Katedra za energetske pretvarače i pogone.

Nastava iz oblasti energetike je više puta reformisana, što je u nastavku ilustrovano sledećom podelom:

1. Nastava do Bolonjskog procesa;
2. Nastava prema Bolonjskom procesu od 2003 do 2013. godine;
3. Nastava prema Bolonjskom procesu od 2013. godine.

Nastava pre Bolonjskog procesa se odnosila na petogodišnje redovne studije (prva godina zajednička



Slika 1. Procentualna raspodela studenata u trećem semestru

za sve odseke i 4 godine prema planu i programu Odseka za energetiku), poslediplomske studije koje su zahtevale polaganje 5 predmeta i izradu magistarske teze i, konačno, izradu doktorske disertacije, što je sve zajedno prosečno trajalo oko 10 godina.

Nastava prema Bolonjskom procesu od 2003 do 2013. godine odnosila se na osnovne studije u trajanju od 8 semestara (prva godina zajednička za sve odseke i 3 godine prema planu i programu Odseka za energetiku) i 240 kredita prema Evropskom sistemu za prenos bodova (ESPB) [2], master akademske studije koje podrazumevaju 60 ESPB kredita odnosno polaganje 5 predmeta i izradu master rada [3] i, konačno, doktorske akademske studije sa 180 ESPB kredita koje podrazumevaju polaganje 10 predmeta, istraživački rad i izradu doktorske disertacije [4].

Nastava prema Bolonjskom procesu od 2013. godine podrazumeva osnovne studije u trajanju od 8 semestara (prva godina zajednička za sve odseke i 3 godine prema planu i programu Odseka za energetiku sa 33 obavezna predmeta i 23 izborna predmeta).

Na master akademskim studijama formirana su dva modula

- modul za elektroenergetske sisteme sa tri smera (Elektroenergetske mreže i sistemi, Razvodna postrojenja i oprema i Obnovljivi izvori energije),
- modul za energetsku efikasnost.

Prema podacima za 2015. godinu, na ovim modulima je bilo upisano ukupno 114 studenata, prema raspodeli prikazanoj na Slici 2.

Konačno, doktorske akademske studije sačinjavaju dva modula

- modul za elektroenergetske mreže i sisteme,
- modul za energetske pretvarače i pogone.

Detaljan spisak predmeta po modulima prikazan je u [5].

4. Podaci o završavanju studija

Prema podacima za 2015. godinu na Elektrotehničkom fakultetu Univerziteta u Beogradu je diplomiralo ukupno 408 studenata, master studije je završilo 292 studenta. Broj doktorskih disertacija prema godinama je dat u nastavku: za 2012. godinu (6 prema Bolonjskom procesu i 16 prema starom programu), za 2013. godinu (11+31), za 2014. godinu (12+5) i za 2015. godinu (23+10). Rok za odbranu doktorske disertacije prema starom programu ističe 30. septembra 2016. godine.

5. Prednosti studiranja na Elektrotehničkom fakultetu Univerziteta u Beogradu

Osnovne prednosti studiranja na Elektrotehničkom fakultetu Univerziteta u Beogradu odnose se na mogućnosti učešća u izradi delova nacionalnih i internacionalnih projekata i studija, odgovarajućoj zastupljenosti literature (samo iz oblasti elektroenergetike

Slika 2. Raspodela studenata na modulima iz oblasti energetike

ima više od 40 naslova, od kojih je nekoliko objavljeno od strane renomiranih stranih izdavača) i mogućnostima zaposlenja (elektroprivredne i elektroprenosne organizacije, instituti, firme iz oblasti projektovanja i izvođenja, privatni sektor, industrija, oblast obnovljivih izvora energije, softversko inženjerstvo, itd.). Osnovni nedostatak studiranja na Elektrotehničkom fakultetu u Beogradu odnosi se na nedovoljan radni prostor koji Fakultet poseduje u ovom trenutku.

6. Zaključci

Na osnovu iznetih podataka o Elektrotehničkom fakultetu Univerziteta u Beogradu mogu se izvesti sledeći zaključci:

- obrazovni sistem je neophodno stalno osavremenjavati sa ciljem uključivanja nastavnih i naučnih metoda koji se koriste na prestižnim univerzitetima u svetu,
- nastava na Elektrotehničkom fakultetu u Beogradu sadrži i teorijsku i praktičnu komponentu,
- naglasak u obrazovanju jeste na završetku osnovnih i master studija, odnosno na završetku studija u ukupnom trajanju od 10 semestara, kao i u izradi odgovarajućih projekata i studija na doktorskim akademskim studijama,

Elektrotehnički fakultet u Beogradu prati nove trendove i ažurira nastavne programe sa ciljem školovanja inženjera elektrotehnike i računarstva za 21. vek. Pritom je neophodno dobro ovladavanje klasičnim disciplinama koje su, kao takve, neophodne za kompletno obrazovanje inženjera elektrotehnike i računarstva. Uvođenje novih disciplina zahteva odgovarajuću ravnotežu između obaveznih i izbornih predmeta.

Literatura:

[1] http://www.etf.bg.ac.rs/index.php?option=com_content&task=view&id=1878&Itemid=211

[2] http://www.etf.bg.ac.rs/index.php?option=com_content&task=view&id=71&Itemid=159

[3] http://www.etf.bg.ac.rs/index.php?option=com_content&task=view&id=41&Itemid=50

[4] http://www.etf.bg.ac.rs/index.php?option=com_content&task=view&id=66&Itemid=74

[5] http://www.etf.bg.ac.rs/index.php?option=com_content&task=view&id=2050&Itemid=225

Podaci o autoru

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web sajt: http://ees.etf.rs

Skupština CIGRE Srbija 2016

Redovna Skupština CIGRE Srbija održana je 23. juna 2016. godine u Domu inženjera „Nikola Tesla" u Beogradu. Odziv članova CIGRE Srbija je bio vrlo skroman (oko 50 prisutnih) u odnosu na aktuelan broj članova u momentu održavanja Skupštine: 145 individualnih i 16 kolektivnih koji mogu da delegiraju po 3 predstavnika. Svi individualni i kolektivni članovi bili su pozvani slanjem pisanog poziva preko pošte, a na sajtu CIGRE Srbija bili su dostupni i svi materijali.

Na redovnoj Skupštini CIGRE Srbija 2016 razmatrani su i usvojeni sledeći materijali:

- Zapisnik sa prethodne Skupštine CIGRE Srbija održane 20. maja 2015. godine na Zlatiboru;
- Izveštaj o radu predsednika i Izvršnog odbora CIGRE Srbija između dve Skupštine;
- Izveštaj o finansijskom poslovanju CIGRE Srbija u 2015. godini;
- Plan Finansijskog poslovanja CIGRE Srbija u 2016. godini;
- Program rada CIGRE Srbija za 2016 – 2017. godinu.

Svi prezentovani materijali su usvojeni bez veće diskusije. Nešto više diskusije je bilo oko (ne)odazivanja CIGRE Srbija, odnosno elektroprivrede Srbije da se predstavi na sajtu međunarodne CIGRE u Parizu i Prvoj konferenciji regionalne CIGRE (SEERC) koja je održana Portoržu – Slovenija od 07. – 08. juna 2016. godine.

Takođe je diskutovano o najvi osnivanja sekcije „mladih" u okviru CIGRE Srbija. Tu se ne misli na neko institucionalno organizovanje, već iznalaženje modaliteta da se studentima i mladim inženjerima elektrotehnike omogući učešće u stručnom radu CIGRE i da se na taj način privuku u članstvo CIGRE. To je praksa međunarodne organizacije CIGRE koju su uveli mnogi nacionalni komiteti u regionu i svetu, kao i neke druge strukovne asocijacije u našoj zemlji (npr. ETRAN, TELFOR, itd.).

Diskusija je vođena i oko Programa rada CIGRE Srbija za 2016 – 2017. godinu u delu koji se odnosi na unapređenje informisanosti članova CIGRE Srbija. Naime, u nedostatku stručnog časopisa iz oblasti elektroenergetike (posle „gašenja“ časopisa „Elektroprivreda“), pojavili su se predlozi da časopis **$CI^{G}RE_{D}$** preraste u stručni časopis. Ipak se na kraju odustalo od te namere, s tim što se traži da CIGRE Srbija kao strukovno udruženje elektroenergetičara kod nadležnih organa i javnih elektroprivrednih preduzeća podrži ponovno izdavanje časopisa „Elektroprivreda“. Dobra je vest da je u međuvremenu Akademija inženjerskih nauka Srbije (AINS) pokrenula inicijativu za obnavljanje časopisa „Elektroprivreda“ uz pomoć JP Elektroprivreda Srbije.

Na kraju treba napomenuti da je na Skupštini CIGRE Srbija 2016 najavljeno da će se do sledeće Skupštine 2017 raditi na izmenama i dopunama Statuta CIGRE Srbija, naročito u delu koji se odnosi na rad i članstvo u Studijskim komitetima.

IZVEŠTAJ SA XVII SASTANKA IZVRŠNOG I NADZORNOG ODBORA CIRED SRBIJA

XVII sastanka Izvršnog i Nadzornog odbora CIRED-SRBIJA održan je 05. aprila 2016. godine u prostorijama bungalova ED Sombor u Somboru. Pre samog sastanka članovi izvršnog i nadzornog odbora obišli su grad Sombor

Na sastanku je jednoglasno usvojen zapisnik sa XVI sastanka Izvršnog odbora CIRED-SRBIJA, održanog 26.09.2015. godine u Novom Sadu. Usvojen je Izveštaj o radu CIRED-SRBIJA za prethodnu 2015. godinu i Izveštaj o finansijskim rezultatima i završni obračun CIRED-SRBIJA za 2015. godinu. Predsednik CIRED Srbija dr Zoran Simendić ukratko je izvestio da je u Beogradu održan sastanak sa predstavnicima CIGRE na kome je je jednoglasno prihvaćena informacija o časopisu CIGRED.

Nakon diskusije o obeležavanju 20 godina rada CIRED Srbije i informacije o održavanju 10. savetovanja donete su sledeće odluke:

- jednoglasno je usvojen predlog Izdavanje publikacije povodom 20 godina rada i održavanja 10 jubilarnog savetovanja.
- jednoglasno je usvojeno da se jubilej obeleži putem Večernjeg koktela sledeće godine u oktobru.
- jednoglasno je usvojen Plan rada CIRED-SRBIJA za 2016.

Predstavnici Agencije BBN i predsednik CIRED Srbija obavestili su prisutne o toku priprema za održavanje 10. jubilarnog savetovanja CIRED SRBIJA u septembru 2016. godine u Vrnjačkoj Banji.

Congres International des Reseaux Electriques de Distribution
International Conference on Electricity Distribution
CIRED Liaison Committee of Serbia
Secretariat
Elektrovojvodina, Bulevar Oslobodjenja 100
21000 NOVI SAD, Serbia
Tel: +381-21-4821-062 /Fax: +381-21-4821-679

Liaison Committee of
SERBIA

10. jubilarno savetovanje o elektrodistributivnim mrežama Srbije

Vrnjačka Banja, između 26. i 30. septembra 2016. godine, hotel “Zvezda“

10. jubilarno savetovanje o elektrodistributivnim mrežama Srbije sa regionalnim učešćem održaće se, kako je već poznato, u Vrnjačkoj Banji, između 26. i 30. septembra 2016. godine, u hotelu “Zvezda“.

Prema dosadašnjim pokazateljima, skup će, sasvim sigurno, ispuniti očekivanja, ako ne i postaviti neke nove rekorde. Na prethodnom Savetovanju registrovano je preko 700 učesnika, dok je procena da je skup posetilo i do 1000 predstavnika različitih organizacija, kompanija i institucija usko povezanih sa oblastima kojima se Savetovanje bavi, što kroz naučne, tako i komercijalne sadržaje.

Za predstojeću konferenciju prijavljeno je 142 rada, od kojih je 107 radova prihvaćeno da bude objavljeno u Zborniku radova i prezentovano učesnicima skupa, uz prateće diskusije. 10 jubilarno savetovanje je prvo savetovanje na kome su nazivi STK usaglašeni sa nomenklaturom međunarodnog CIRED.

- STK1: KOMPONENTE, predsednik Prof. dr Dragan TASIĆ, Elektronski fakultet Niš, prihvaćeno je 27 radova,
- STK 2: KVALITET ELEKTRIČNE ENERGIJE I ELEKTROMAGNETNA KOMPATI-BILNOST, predsednik Prof. dr Vladimir KATIĆ, Fakultet tehničkih nauka Novi Sad, prihvaćena su 22 rada,
- STK 3: UPRAVLJANJE I ZAŠTITA, predsednik mr Dušan VUKOTIĆ, EPS Distribucija Beograd, prihvaćeno je 16 radova,
- STK 4: DISTIBUIRANA PROIZVODNJA I EFIKASNO KORIŠĆENJE ELEKTRIČNE ENERGIJE, predsednik dr Željko POPOVIĆ, EPS Distribucija, Ogranak ED Subotica, prihvaćena su 22 rada,
- STK 5: PLANIRANJE DISTRIBUTIVNIH SISTEMA, predsednik Prof. dr Aleksandar JANJIĆ, Elektronski fakultet Niš, prihvaćeno je 9 radova,
- STK 6: TRŽIŠTE ELEKTRIČNE ENERGIJE I DEREGULACIJA, predsednik dr Nenad KATIĆ, Schneider Electric DMS Novi Sad, prijavljeno je 6 radova.

I ove godine će se u okviru Savetovanja održati Forum na temu Smart Grid-a, čiji će moderator biti predsednik Nacionalnog komiteta CIRED Srbija, dr Zoran Simendić. U okviru Foruma Smart Grid biće diskusije na temu 5 radova prijavljenih za ovu aktuelnu temu. Nakon prezentacije pomenutih radova, određeni broj kompanija prezentovaće svoja iskustva i rešenja na datu temu.

Među prihvaćenim radovima autori 82 rada su iz Srbije, dok su autori preostala 23 rada iz Bosne i Hercegovine, Crne Gore, Mađarske, Rumunije, Nemačke i Španije.

U okviru prateće komecijalne izložbe Savetovanja, svoje proizvode i usluge predstaviće više od 50 kompanija iz zemlje i inostranstva. Do sada je 51 kompanija potvrdilo svoje učešće u Programu marketinga, među kojima je 5 zlatnih sponzora, kompanije Omicron, Schneider Electric, ABB, Siemens i GE Energy, kao i 7 velikih sponzora: Weidmuller, Elnos Group, Elektrokoil, Minel Trafo, Institut Mihajlo Pupin, Minel Dinamo i Meter & Control.

Kada su u pitanju istaknuti predstavnici struke iz regiona kao i šire, Nacionalni komitet CIRED Srbije uputio je poziv za gostovanje predsedniku međunarodnog CIRED-a gospodinu Theodoru Connoru, sekretaru međunarodnog CIRED-a gospođi Michele Delville i predsednicima Nacionalnih komiteta zemalja iz okruženja.

Planira se organizacija tri okrugla stola na teme :

1. “Restrukturiranje elektrodistributivnog sektora u Srbiji”, Andrija Vukašinović
2. “Problematika smanjivanja netehničkih gubitaka (NTG)“, Vladimir Šiljkut
3. “Praćenje pokazatelja pouzdanosti DEES u ODS EPS Distribucija“, Željko Popović, ODS EPS Distribucija Novi Sad, Aleksandar Krstić, ODS EPS Distribucija Niš i Dimitrije Nikolajević, ODS EPS Distribucija, Beograd

Pored 10 jubilarnog savetovanja o elektrodistributivnim mrežama Srbije, Nacionalni komitet CIRED SRBIJE 2017. godine obeležava 20 godina rada. Osnovan je u Novom Sadu 8. oktobra 1997 godine. Doneta je odluka da se krajem sledeće 2017. godine svečano obeleži 20 godina rada i 10 jubilarno savetovanje. Povodom jubileja će se izdati odgovarajuća publikacija.

17. SIMPOZIJUM UPRAVLJANJE I TELEKOMUNIKACIJE U ELEKTROENERGETSKOM SISTEMU

Vršac, 16.-19. oktobar 2016, hotel "Srbija"

17. Simpozijum "Upravljanje i telekomunikacije u elektroenergetskom sistemu" održaće se od 16. do 19. oktobra 2016. godine u Hotelu "Srbija" u Vršcu.

Organizatori Simpozijuma su studijski komiteti C2 - Upravljanje i ekspolatacija EES i D2 - Informacioni sistemi i telekomunikacije CIGRE Srbija.

Očekuje se da će, kao i ranije, pokrovitelji i sponzori Simpozijuma biti elektroprivredna preduzeća, proizvođači upravljačke, zaštitne i komunikacione opreme, projektantska preduzeća, razvojni instituti i dr.

Tokom dvodnevnog rada Simpozijuma biće prezentovan i diskutovan ukupno 31 prethodno recenziran rad, prema dole navedenom spisku.

1. SPISAK PRIHVAĆENIH RADOVA

STK C2 Upravljanje i eksploatacija EES

Red. broj	Autori	Naziv rada	Firma
1	Petar Pavlović, Igor Belić, Saša Minić	Analiza promene gubitaka aktivne i reaktivne snage sa promenom napona na konzumu elektrodistributivne mreže Velika Plana sa implementiranim statičkim karakteristikama opterećenja u modelu mreže	EINT
2	Nikola Georgijević, Ana Radovanović, Milica Dilparić, Dragan Đorđević, Dejan Milošević	Regulacija napona - analiza ispunjenosti zahteva iz Pravila o radu prenosnog sistema i smernice za odabir parametara novih agregata	EINT
3	Nemanja Gak, Saša Zdravković	Problematika visokih vrednosti napona na prostoru juga Srbije	JP EMS
4	Marija Đorđević, Stanko Vujnović, Stefan Tirnanić, Bojan Stamenković, Andrijana Đalović	Procena adekvatnosti prema ENTSO-E metodologiji u okviru regionalnih koordinacionih centara	JP EMS SCC
5	Srđan Subotić, Vladimir Ilić	Upravljanje rizikom prekida isporuke	JP EMS
6	Nikola Obradović, Velimir Nešić, Duško Tubić	Proračun regulacione rezerve na probabilističkoj osnovi	JP EMS
7	Ana Veselinović, Petar Petrović	"Imbalance Netting"	JP EMS
8	Stanko Janković, Klaus Langschied, Ognjen Paleka, Dušan Banković, Vladimir Barac,Gordana Luković, Bojana Mihić, Đorđe Golubović, Desimir Trijić, Vladimir Đikić	Komparativna analiza metodologija za proračuna struja kratkog spoja saglasno prvom i drugom izdanju međunarodnog standarda IEC 60909-0	GOPA JP EMS
9	Petar Petrović, Ana Veselinović	Problem visokih napona u prenosnom sistemu, uzroci, posledice i predlog rešenja	JP EMS
10	Aleksandar Latinović, Nikola Obradović, Nikola Lukić	Provera odziva primarne regulacije učestanosti tokom determinističkih odstupanja učestanosti	JP EPS
11	Vladimir Bečejac, Miloš Mosurović, Branko Šumonja, Duško Aničić	Estimator stanja u Nacionalnom dispečerskom centru Srbije i njegove primene	JP EMS
12	Milan Đorđević, Aleksandar Latinović, Nikola Lukić	Uticaj kapitalnih remonta, eksploatacije i uslova rada na mogućnosti sinhronih generatora JP EPS u pogledu generisanja/apsorbcije reaktivne snage i regulacije napona u prenosnoj mreži Srbije	JP EPS
13	Saša Zdravković, Jovica Vidaković, Miloš Mosurović, Duško Aničić	Ispad sva tri sistema sabirnica 220 kV u TS Obrenovac 30.04.2016.	JP EMS
14	Ninel Čukalevski	Upravljanje naponsko-reaktivnim prilikama u cilju minimizacije gubitaka - moguće rešenje za EES Srbije	IMP
15	Miloš Stojić, Ninel Čukalevski, Jelena Veselinović, Goran Jakupović, Igor Bundalo	Primena merenja faznih uglova u estimaciji stanja u okviru rezervnog SCADA/EMS sistema u NDC Elektromreže Srbije	IMP JP EMS
16	S. Krstonijević, N. Čukalevski, P.Lučić, G.Jakupović	Implementacija softverskog paketa za kratkoročnu prognozu potrošnje	IMP
17	Mirela Đurđević, Vladimir Grujić	Unapređenje veze za razmenu podataka između SCADA/EMS i SRAAMD sistema u Nacionalnom dispečerskom centru JP EMS	JP EMS

STK D2 Informacioni sistemi i telekomunikacije

Red broj	Autori	Naziv rada	Firma
1	Jovanka Gajica, Vladimir Čelebić, Iva Salom, Milenko Kabović, Anka Kabović, Lazar Mrkela, Srđan Mitrović, Milan Milosavljević, Dušan Maksić	Prikaz sistema za centralizovano nadgledanje terminala za prenos signala telezaštite	IMP Matematički fakultet JP EMS
2	Vladimir Čelebić, Anka Kabović, Milenko Kabivić, Jovanka Gajica, Iva Salom, Srđan Mitrović, Milan Milosavljević, Dušan Maksić	Eternet kao rezervni put za prenos signala telezaštite – rezultati ispitivanja	IMP JP EMS
3	Vladimir Pustahija, Radojica Graovac	Udaljeni monitoring u realnom vremenu za transformatore i GIS parcijalno pražnjenje u primarnim trafostanicama - primer iz elektroprivreda zemalja Bliskog istoka	Energoprojekt ENTEL
4	Dragomir Marković, Radojica Graovac	Migracija telekomunikacionog sistema sa SDH na MPLS platformu - primer iz elektroprivreda zemalja Bliskog istoka	Energoprojekt ENTEL
5	Miloš Stanković, Branislav Šašić, Vladimir Nešić	Ispitivanje elektromagnetske kompatibilnosti RTU/PLC uređaja piko Atlas-RTL	IMP - Automatika
6	Predrag Marić, Branislav Šašić, Vladimir Nešić	Integracija GNSS i GPRS sa RTU/PLC uređajima	IMP - Automatika
7	Goran Stefanović, Miloš Stojić, Ivana Kršenković, Goran Jakupović, Ninel Čukalevski	Određivanje energizovanosti elektroenergetskih mreža u realnom vremenu bazirano na topološkoj analizi	IMP
8	Nikola Stojaković	Web aplikacija za daljinski pristup, prikupljanje podataka i praćenje rada udaljenih inženjerskih stanica u elektroenergetici	IMP
9	N. Jemuović, M. Tasić, A. Car	Iskustva u realizaciji sistema daljinskog nadzora u nacionalnom distributivnom dispečerskom centru	IMP - Automatika
10	Radoslav Raković	Rizici u IKT projektima za potrebe elektroprivrede	Energoprojekt ENTEL
11	Radmila Partonjić, Predrag Stefanov	Komunikacija zaštitnih releja u okviru standarda IEC 61850	ETF Beograd
12	Aleksandar Marjanović, Predrag Stefanov	Modelovanje sistema upravljanja i zaštite tipičnog visokonaposkog postrojenja prema standardu IEC61850	JP EMS ETF Beograd
13	Saša Milić, Dejan Misović, Nikola Miladinović, Aleksandar Žigić	IT koncepcija sistema za detekciju kvara železničkih vagona	EINT
14.	Bojan Milinković, Jasmina Mandić-Lukić	Primena WiMAX tehnologije u srednjenaponskoj distributivnoj mreži	Energoprojekt ENTEL

2. PROGRAM MARKETINGA

Predviđeno je i uključenje marketinških aktivnosti zainteresovanih sponzora u rad Simpozijuma u formi tehničke izložbe i/ili predavanja.

3. ORGANIZACIONI ODBOR

Simpozijum organizuje Organizacioni odbor u sastavu:

- dr Ninel Čukalevski, Institut Mihajlo Pupin, Beograd, predsednik STK C2 CIGRE Srbija, predsednik OO
- mr Jovanka Gajica, Institut Mihajlo Pupin, Beograd, predsednik STK D2 CIGRE Srbija, zamenik predsednika OO,
- Nada Turudija, JP Elektromreža Srbije, Beograd , član OO,
- mr Danilo Lalović, JP Elektroprivreda Srbije, Beograd, član OO.

uz značajnu podršku Sekretarijata CIGRE Srbija i kontinualni monitoring od strane Izvršnog odbora CIGRE Srbija.

SEEPEX
operator tržišta koji upravlja organizovanim tržištem električne energije

SEEPEX a.d. Beograd, u svojstvu operatora tržišta upravlja organizovanim tržištem električne energije. Kompanija je osnovana 14. jula 2015. godine kao akcionarsko društvo nastalo partnerstvom između JP Elektromreža Srbije - JP EMS (75%) i Evropske berze električne energije - EPEX SPOT (25%).

Funkcionisanje SEEPEX oslanjaće se na ETS sistem za trgovanje, koji EPEX SPOT koristi za upravljanje radom svojih tržišta. Funkciju kliringa i finansijskog poravnanja će, u skladu sa najboljom evropskom praksom, obavljati klirinška kuća „European Commodity Clearing" (ESS). Na taj način članovi SEEPEX imaju koristi od uspostavljanja i primene visokih standarda, kako u smislu usluga trgovanja, tako i u smislu klirinških usluga.

Formiranje organizovanog tržišta električne energije/berze elektične energije SEEPEX predstavlja ključni korak u formiranju slobodnog veleprodajnog tržišta električne energije, obezbeđujući fleksibilne instrumente za efikasnu, transparentnu i sigurnu trgovinu standardizovanim proizvodima. Značaj razvoja organizovanog tržišta se reflektuje kako na sam razvoj tržišta električne energije u Srbiji i regionu, tako i na samu privredu Srbije kroz poboljšanje uslova za donošenje investicionih odluka.

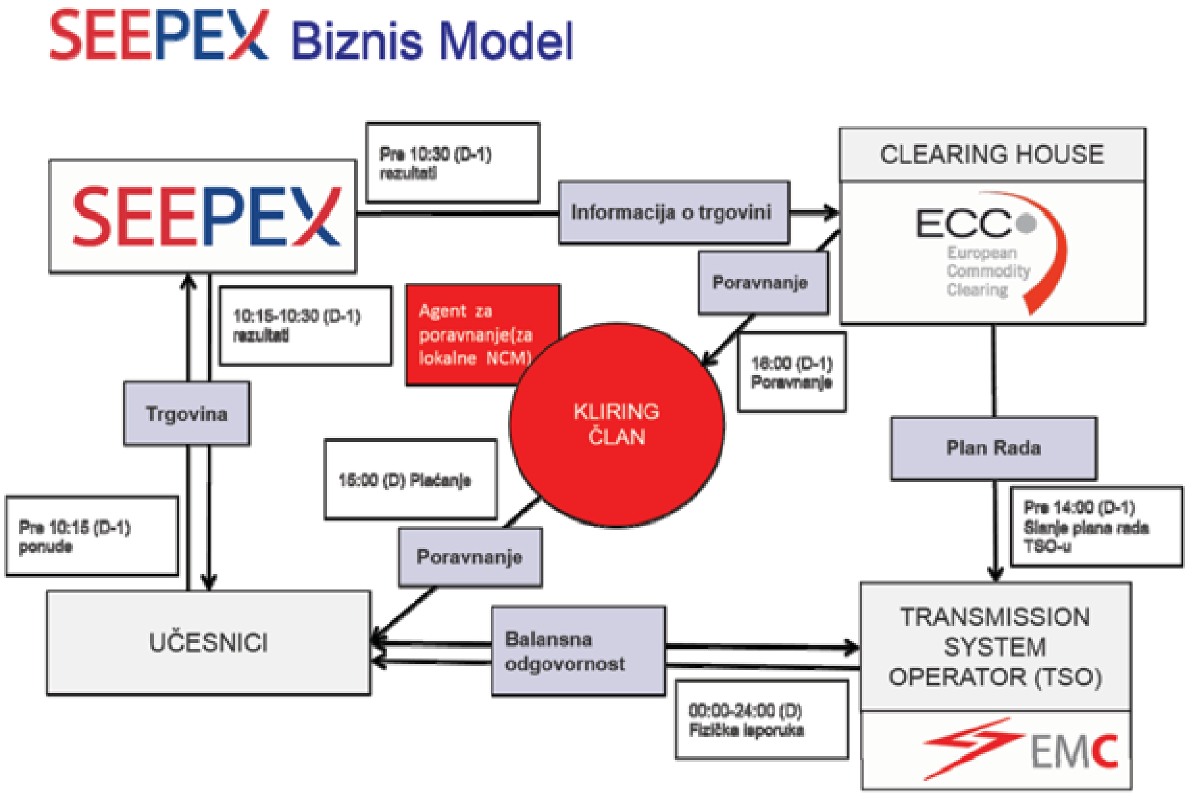
Benefiti koje donosi formiranje SEEPEX na razvoj tržišta električne energije u Srbiji i regionu se ogleda kroz:

- dobijanje novog proizvoda,
- harmonizovanje procesa trgovine kao i kliringa na organizovanom tržištu u skladu sa najboljom evropskom praksom,
- transparentan mehanizam formiranja cene,
- dobijanje i objavljivanje referentne cene,
- finansijsku sigurnost transakcija zaključenih na organizovanom tržištu kroz centralizovani postupak kliringa i finansijskog poravnanja,
- pospešivanje konkurencije.

Razvoj SEEPEX koji vodi uspostavljanju efikasnog i likvidnog veleprodajnog tržišta je preduslov za uspostavljanje konkurentnog maloprodajnog tržišta, a samim tim to će predstavljati veliki benefit za krajnjeg kupca.

Na organizovanom tržištu električne energije mogu da učestvuju domaće i strane kompanije koje poseduju validnu licencu izdatu od Agencije za energetiku Srbije. Strane kompanije moraju da poseduju licencu za snabdevanje na veliko električnom energijom, dok domaće moraju da poseduju jednu od sledećih licenci: licencu za snabdevanje na veliko, licencu za snabdevanje ili licencu za proizvodnju električne energije. Kao domaći učesnik može se pojaviti i krajnji kupac koji kupuje električnu energiju za svoje potrebe (kao što su npr. industrijski potrošači, TSO, DSO).

Nakon četiri i po meseca rada moguće je dati prvi pregled ostvarenih rezultata. Dosadašnji rad je pokazao da je odabrani poslovni model uspešno implementiran. SEEPEX organizuje dnevne aukcije 7 dana u nedelji. Učesnici na organizovanom tržištu šalju svoje ponude za kupovinu i prodaju preko SEPEX ETS platforme za trgovinu (počev od 45 dana unapred, do 10:15 časova u danu D-1). Knjiga ponuda se zatvara u 10:15 časova i rezultati se objavljuju do 10:30. Informacija o trgovini se odmah šalje ECC radi obavljanja poslova kliringa. Pre 14:00 časova u danu D-1 ECC šalje vozni red EMS, a posle 16:00 časova informaciju o poravnanju svim kliring članovima. Kliring članovi šalju informaciju o poravnanju učesnicima na organizovanom tržištu (preko njihovih odgovarajućih agenata za poravnanje) i plaćanje se vrši do 15:00 časova u danu isporuke D. Na SEEPEX se trguje satnim produktom, a trgovina se obavlja u evrima. TSO je odgovoran za fizičku isporuku (00:00 – 24:00 u danu D). Kako bi bili u mogućnosti da se registruju na SEEPEX, učesnici prvo moraju imati rešeno pitanje balansne odgovornosti sa EMS-om i potpisati odgovarajuće ugovore sa ECC i SEEPEX.

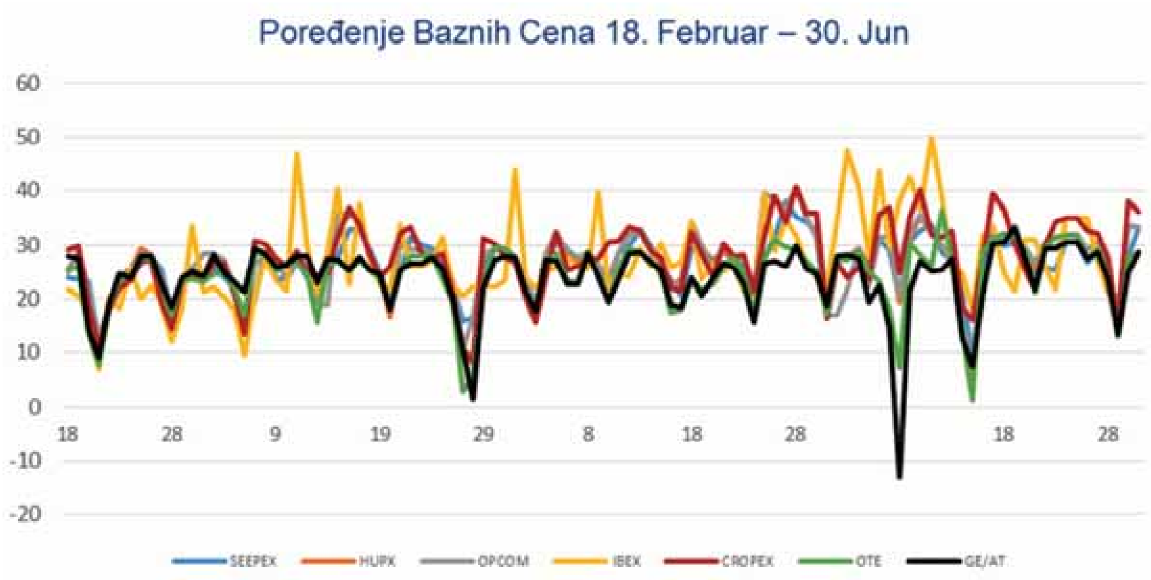


Slika 1. SEEPEX biznis model

SEEPEX je sa operativni radom počeo 17.februara 2016 sa 5 članova. Početni broj članova porastao je na 10, a do kraja godine se očekuje barem oko 20 članova. Trenutno je oko 10 članova u procesu registracije na srpskom tržištu električne energije. Na slici 2 je prikazan rast članstva na SEEPEX tokom prvih pet meseci.

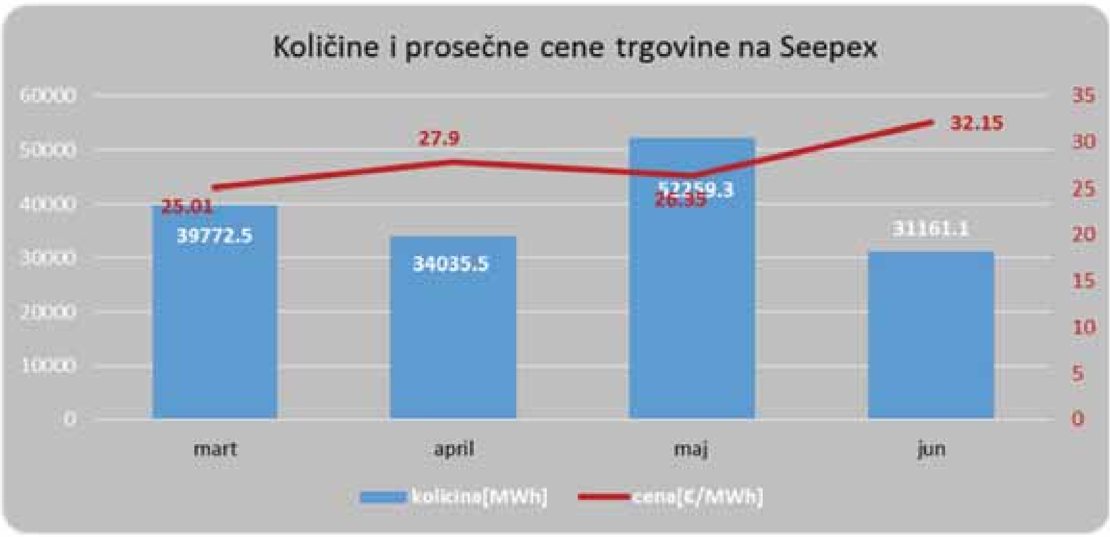
Slika 2. SEEPEX članstvo

Ako se uporede cene postignute na SEEPEX sa ostalim berzama, može se zaključiti da one u potpunosti prate kretanje cena u ostalim tržišnim oblastima, čime se pokazuje ispravnost primenjenog modela i opravdanost uspostavljanja organizovanog tržišta električne energije u Srbiji. Može se zaključiti da cena dobijena na ovako organizovanom tržištu u potpunosti predstavlja referentnu cenu.



Slika 3. Cene na SEEPEX uporedno sa evropskim organizovanim tržištima

Količina trgovanja gledano od početka operativnog rada SEEPEX pokazuje trend rasta što je ohrabrujuće i što potvrđuje da implementirani poslovni model dobro funkcioniše. Konstantno povećanje broja učesnika dovodi i do povećanja likvidnosti organizovanog tržišta, a time i do realnije referentne cene. Na slici 4 su dati rezultati sumarnih količina trgovanja i prosečenih cena ostvarenih od početka rada.



Slika 4. Količine i cene na SEEPEX ostvarene u prva četiri meseca trgovine

U skladu sa evropskim ciljanim modelom za uspostavljanje unutrašnjeg tržišta električne energije Srbija će se spojiti sa svojim susedima. Položaj Srbije je interesantan u regionalnoj perspektivi zbog veoma aktivne prekogranične trgovine. Spajanje tržišta će podstaći razvoj organizovanog tržišta što će također doneti benefite učesnicima.

Spajanje tržišta bi trebalo da bude izvršeno putem ETS trgovinske platforme pošto je ona već u skladu sa zahtevima koje PCR (algoritam za spajanje tržišta) nalaže - zahvaljujući iskustvu EPEX SPOT pri spajanju tržišta. Spajnje našeg tržišta sa 4MMC inicijativom (spojena tržišta Češke, Slovačke, Mađarske i Rumunije) trebalo bi da bude logičan korak u bliskoj budućnosti.

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C2 – 113

Real time synchronous generator dynamic reactive reserve monitoring by coordinated reactive power voltage controller

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SUMMARY

The paper discusses a solution that facilitates an improved functionality of the Coordinated Reactive Power – Voltage Controller (CQVC), used for coordinated control of voltage (V) and reactive power (Q) at the power plant that enables Transmission System Operator (TSO) real time insight into the power plant contribution to voltage ancillary service. The main CQVC role is to perform slow HV busbar voltage control by automatic adjustment and sharing of Q among generators. Additionally, the CQVC also performs the following functions in real time: i) calculates total minimum and maximum reactive power available at the power plant, ii) monitors power plant reactive power output, iii) calculates dynamic reactive reserves of each generator and power plant as a whole, iv) determines the price region that each generator operates within. All these data the CQVC communicates to TSO thus enabling the realistic recognition of each generator/power plant contribution (participation) to voltage control and also enabling the system voltage stability reserve evaluation. The goal is to provide TSO data that will allow adequate reactive power reserve management and, at the same time, maximize benefits to society at large by fare reactive power pricing. The proposed solution additionally enables control and monitoring of busbar voltage of any local voltage control area.

KEYWORDS

Generator reactive capability, P-Q diagram, Coordinated reactive power-voltage controller, Reactive power cost.

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1. INTRODUCTION

Deregulation of electrical energy market, large applications of smart control laws, a significant impact of distributed generators and the rapid development of powerful communication networks, which horizontally and vertically bound all participants of unified power system frame, have influenced the changes in working conditions and created new opportunities in all aspects, including power system control. If solely the power system voltage (V) and reactive power (Q) flows are considered, it can be observed that there are intensive fluctuations in voltage levels and reactive power demand during different seasons and during the day. Transmission System Operator (TSO) needs to procure and dispatch reactive power in the most efficient way in order to facilitate more transactions over the power network. For dealing with these conditions the TSO operates according to the following rules and recommendations: the National Grid Code, algorithms and devices for power system monitoring and control and the reactive power pricing methodology [1], [2]. Development of smart control and telecommunications enabled the development and application of devices which can perform real time control and monitoring of voltages and delivered reactive power from power plants. Furthermore, current recommendations of ENTSO-E's working group state that capital cost and available amount of capacity have to be compensated in order to stimulate large participants to provide voltage ancillary services [3].

Coordinated Q-V Controller (CQVC), for automation of reactive power allocation among synchronous generators (SG) in power plant, has been recently installed in two largest steam power plants in Serbia. The CQVC represents a new level of SG/power plant and power system coupling. The CQVC operates with HV busbars and SG terminal voltage measurements, and HV and SG terminal real (P) and reactive (Q) power measurements. Based on these measurements the equivalent Thevenin reactance of network connected to the HV busbars is estimated and used in control algorithm. The allocation of Q among SGs is performed regarding composite limits imposed on SG's capability curve by underexcitation (UEL) protection and limiters, overexcitation (OEL) and overcurrent (OCL) limiter, overvoltage protection and terminal voltage operating limits (±5% of rated value) [4]. The result is that uniform reactive power reserve is achieved at all the generators in the power plant. The maximum and minimum Qs (for actual SG's operating point) are calculated using multi-parameter function which takes into account available range both Q and terminal voltage. The control algorithm ensures that all generators move simultaneously towards, and reach at the same time, their respective limits when the bus switches from P-V to P-Q type [5], [6] and [7].

The information of the utmost importance for the TSO is minimum and maximum reactive power available at power plant busbars as well as the dynamic reactive reserves of each generator and power plant. At present this information is both, requested by TSO when needed and the Q set point is communicated to the plant by phone.

This paper describes the methodology for application of CQVC for real-time monitoring of: i) the actual available reactive power at the SG's terminals at given operating point, ii) the available dynamic reactive power reserve and iii) the range of cost of reactive power production.

2. THE NEED FOR MONITORING AVAILABLE REACTIVE POWER

The disproportion between Grid Code requirements and voltage control capability of existing SGs and strong feedback influence of network conditions on SG's operating limits are the main reasons for monitoring the reactive power operating range in real time. In [8] it is suggested that qualitative comparison of costs and benefits shall be performed related to the application of requirements to existing power generating modules taking into account network-based, market-based or socio- economic benefits.

The disproportion between Grid Code requirements [9] and voltage control capability of existing SGs is illustrated in Fig. 1 for case of unit A1 and in Fig. 2 for unit A6 at Steam Power Plant (SPP) TENT A. The Grid Code states that SG must be capable of performing voltage control permanently within the range outlined with thick dashed (brown) line in Fig. 1, for the normal voltage range at the point of common coupling (PCC) of the plant. This control should be possible regardless of plant's participation in the primary and secondary control [9], where V is voltage of the transmission grid at

the PCC and cos(phi) is power factor at the PCC. The main constraints for generating or absorbing reactive power are set by capability curve (Fig.3 and Fig. 4) and by request that the generator terminal voltage should not exceed ± 5% of rated value. When the generator capability curve is plotted in V- cos(phi) plane the resulting achievable voltage control region of SGs in SPP TENT A is outlined with thin solid (blue) and dash-dot (red) lines in the figure. The disproportion between existing SG capability and Grid Code requirements is noticeable. The Grid Code defines obligatory requirements for connection of new power plants while the existing plants are required to deliver their updated capabilities, even though there is no strict requirement for compliance with Grid Code for the plants that had been connected to the transmission system before the Grid Code was released.

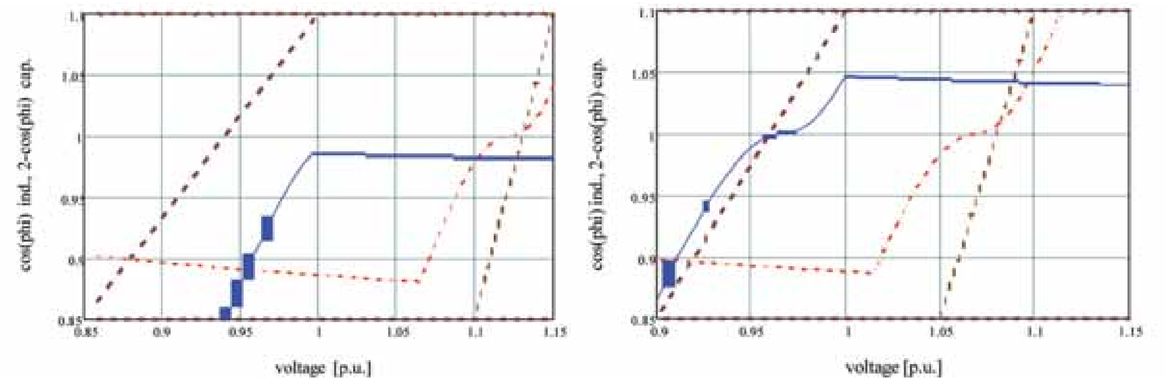

Fig. 1 The disproportion between Grid Code and voltage control capability of existing SGs in SPP TENT–A, units A1 (connected to 220 kV bus) and A6 (connected to 400 kV bus). The Grid Code requirement - thick dashed (brown) line, existing generator capability solid (blue) and dash-dot (red) lines

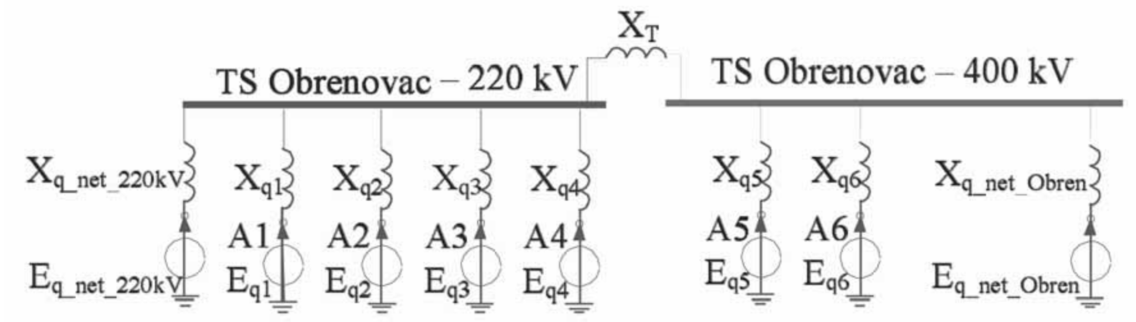

Fig. 2 SPP TENT-A single line diagram

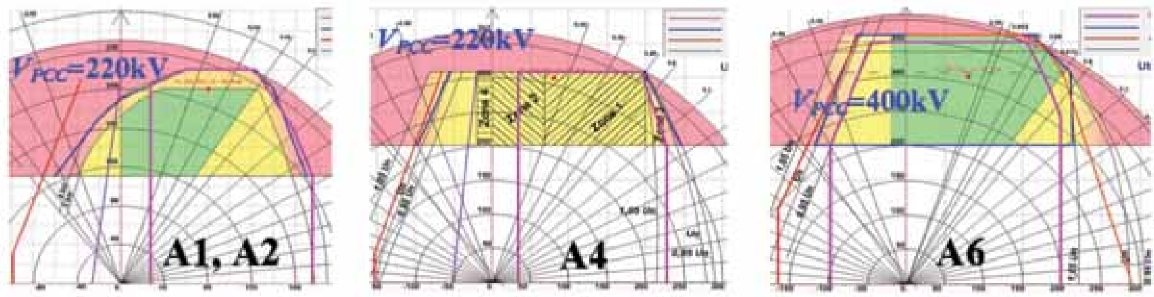

Fig 3 Synchronous generators' P-Q diagrams for units A1 to A6 in SPP TENT-A. For generators A4 and A5 price related zones of P-Q diagram are suggested. Slow acting reactive capability thick - pink line, UEL - purple line, underextion protection – red line

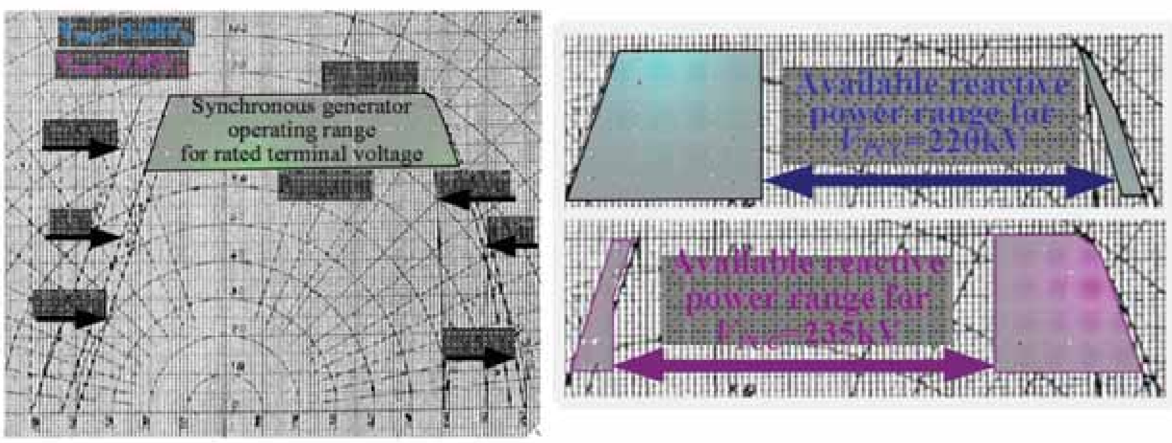

Fig. 4 Generator reactive power capability: green area - generator capability determined by generator PQ diagram; blue area - generator capability when V_{PCC}=220kV; purple area - generator capability when V_{PCC}=235kV (different from rated value)

The reason for further reactive power capability reduction is feedback effect of network voltage on the available reactive capability. The reactive power flow through step-up transformer is determined by voltage difference between the generator's terminals and PCC, and step-up transformer reactance (if P and Q are treated separately). The ± 5% of rated voltage value could be reached with reactive power "bottled" in generator. Fig. 4 shows the available reactive power range for generators A4 and A5 for different network voltages. The generator minimum capacity is limited by terminal voltage limit of

0.95 p.u., which is far from generator stability or thermal limitations, thus the step-up transformers of generators A3, A5 and A6 are equipped with tap changers (TC) to ensure better use/regulation of Q at different voltage levels. The Serbian power system is characterized by extremely high voltages during the night due to high Q in-feed from interconnection with neighbouring systems. During the winter the voltages tend to be low during the day so there are opposite demands on TC. The actions on TC are supposed to be undertaken in periods non shorter than 2 months (the step-up transformer needs to be unloaded). Even with the newest generation of on-load tap changers, which are claimed to be more reliable, it has to be taken into account that step-up transformer maintenance is longer and more expensive with each tap change. The consequence is that the generator capability needs to be monitored in a real time since it can vary significantly based on numerous factors [10].

In the most events the generator cannot fulfil the required reactive contribution to transmission network as it is required by Grid Code. Most of the generators during summer can be necessarily derated because of high ambient temperatures. Communicating changes of generator reactive capability limits in a timely and accurate manner can help TSOs to have an insight into Q reserve of the system [2]. The MVAr/voltage capability of each generator or group of generators therefore should be monitored. Further, the operators shall be provided with on-line indications of available reactive capability from each group of generators and reactive power/voltage margin.

Massive outages experienced in last 20 years in the world [11] are reported to be caused by long term (seconds to minutes order) voltage instabilities. Thus of primary interest is continuous voltage control which should keep voltage profile flat to the extent possible by maximizing of reactive power reserve. Reactive power outputs of generators are good indicator for voltage security, as far as angle stability is not an issue. The following ranges/limitations have been reported to be of interest:

- Fast acting Q ranges/limits which are available for transients compensation. Voltage level is defined by synchronous generator voltage protection (1.2 p.u. for 5s, 1.25 p.u. for 0.5s). Synchronous generator rotor limits activation results in rotor current control. Limit is defined by rotor current limit and as short term overload ability of up to 200% for 10s [12] is permitted.
- Q ranges/limits available for long term slow voltage variations. For generators used with step-up transformers and unit auxiliary transformers, the useful MVAr operating range should be considered because the entire MVAr operating range may not be available due to voltage range limitations [2]. Concerning variations from rated voltage, the generators shall

be thermally capable of continuous operation within the limits of their reactive capability curves for the voltage range of ±5% about the rated voltage. As operating point moves away from rated voltage the temperature rise occurs. Continuous operation near limits may cause premature insulation ageing (two to six times faster [13] than at rated voltage). In order to avoid unnecessary generator temperature increase the available reactive power range with respect to generator terminal voltage should be calculated and superimposed on capability curve.

By communicating these limits in real time to TSO, they will have the relevant set of data from power plant for system wide voltage/reactive power control. Therefore, the TSO should be capable to monitor the available reactive power operating range in real time and incorporate it into software for System Stability and Optimal Power Flow calculation to ensure safe, secure and economical operation of the system.

3. MEASUREMENT OF AVAILABLE REACTIVE POWER RESERVE

All existing plants have control systems managing their generating processes. Programmable Logic Controllers (PLC) are present across sites providing and supporting continuous, semi-continuous or batch processes. Distributed Control Systems (DCS) combine local processes into the unit sequencing and monitoring. However, there is still a lack of integration of local control systems dedicated to power plant unit processes into an overarching real-time optimisation and scheduling system controlling and monitoring the operations of the whole plant. The DCS at plant level performs: data exchange with higher (control center) and lower control levels, communication with devices at the function areas level, selection of the control place/mode, control of power plant common equipment (switch yard control, station service electrical systems control), data archival, external time synchronizing. This plant integration is especially challenging for unifying all power plant units in "the virtual plant unit" thus controlling the power plant as a single power unit.

In order to enable the joint operation the coordinated reactive power voltage controller (CQVC) maintains the Q-V characteristic at PCC. It operates with reference voltage value at PCC and reactive power slope value and calculates, for existing network conditions, required reactive power that should be fed at PCC. The allocation of reactive power is based on maximization of reactive power reserve at PCC. The algorithm combines different criteria including the voltage at generator's terminals, thermal and stability limits of generator with step-up transformers and additional operating limits, ensuring that units can release maximal support to the system.

For purpose of SG's reactive power reserve measurements the appropriate algorithm is implemented in CQVC, the flow chart is shown in Fig. 5 [5], [6] and [7]. After commissioning the CQVC the TSO demanded that output of this algorithm should be communicated to control centre in real time. At this point in time the following data (given in blue colour in Fig. 5) are communicated to TSO [14]: i) maximal and minimal available reactive power for slow voltage variations at PCC (detail 1 in Fig.6); ii) generated Q of individual generators (detail 2 in Fig.6); iii) individual generator and total Q reserve used (detail 3 in Fig.6) with respect to slow voltage variations.

Additional information however, should be added to this set of data. For fast voltage variations the generator's response is restricted by excitation system limiters (over/under excitation limiter, overcurrent limiter). Those limiters are positioned according to generators capability curve [2] and operating limits (most often induced by equipment ageing or some equipment malfunction that could be tolerated for certain time period for example until the scheduled maintenance occurs). Since they are dependent on generated real power, these limits should be communicated to TSO in real time, too. When excitation limiters are activated the rotor current is kept at maximal safe value for certain time period [12]. The reactive power level, however, is delivered to the system as constant value, not intended to perform voltage control and only prevents overheating of certain parts of the generator. The generator is therefore seen as not giving any support to the system voltage control and its reserve is seen as effectively being zero [2]. This information however could be a very important for TSO to

prevent large and important units operating at suboptimal level that ultimately could lead to voltage collapse.

The optimal support to the system does not provide optimal temperature allocation among the generators. Larger P output results in larger Q and higher temperatures [14] since equal reactive load coefficient is calculated on full reactive range (negative reactive power has been taken into account). Power plant deprecates these additional losses and suggests additional reimbursement. Losses price regions could be determined and communicated to TSO, see Fig. 3 and Fig. 7.

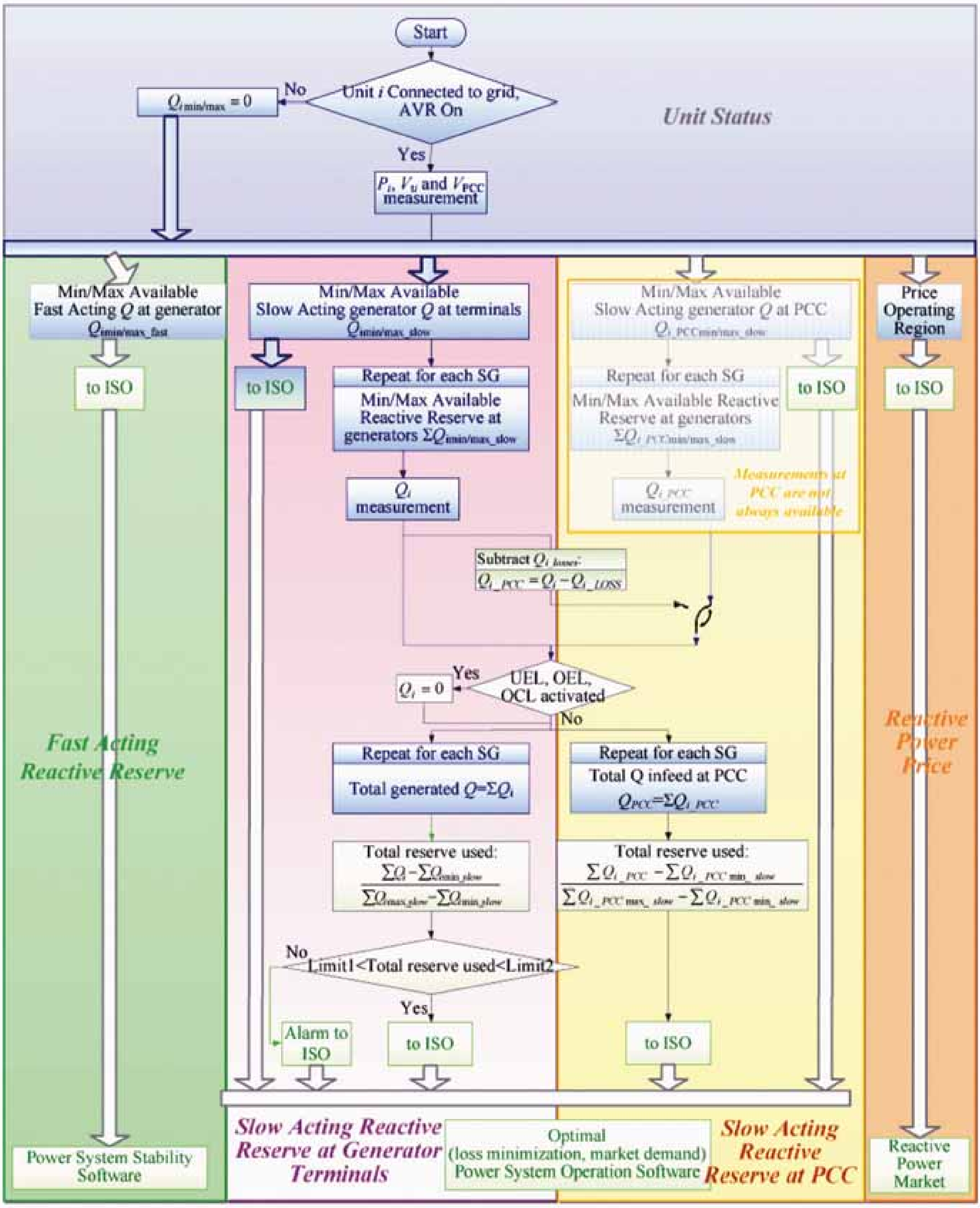

Fig. 5 Reactive power reserve measurement algorithm flow chart

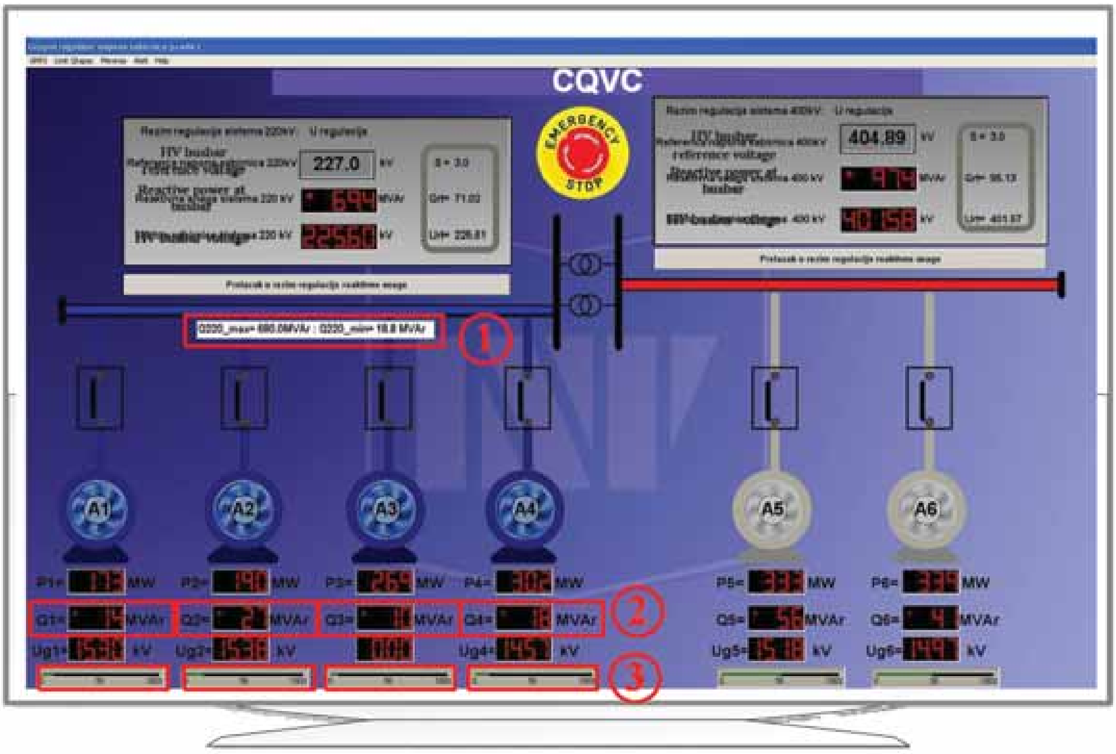

Fig. 6 CQVC operator terminal

At the beginning (grey area in Fig. 5) algorithm checks the status of the power units (connected to the grid or not) and the number of units connected to the grid. Afterwards it branches out into three directions, measuring the fast acting reactive power reserve at generator terminals (green area in Fig.

5) and slow acting reactive power reserve at generator terminals (pink area in Fig. 5) and PCC (yellow area in Fig. 5). Fast acting reserve is determined by UEL, lower limit, and OEL and OCL , as upper boundary. Those boundaries vary with real power and voltage:

$$Q_{i\min\_fast} = Q_{i\min} \text{ by UEL settings for actual } P_i \text{ and } V_{ti} \qquad (1)$$

$$Q_{i\max\_fast} = Q_{i\max} \text{ by min(OEL and OCL settings for actual } P_i \text{ and } V_{ti}) \qquad (2)$$

where Q_{imin/max_dyn} is minimal/maximal reactive power available at generator *i* for fast acting voltage control, $Q_{imin/max}$ minimal/maximal reactive power available at generator *i* by certain criteria, P_i, V_{ti} generator *i* generated real power and voltage at generator terminals. They are calculated accurately by actual measurements and limiters characteristics. They should be accessible in real time to the power system to provide maximal support for short term transients. The data format should be adjusted to power system stability estimation software available to TSO.

Slow acting reserve is more restrictive. In order to maximize it close cooperation, extensive exchange of information and clear recognition of interest of each participant are needed. Operation mode (voltage control or limiter activation mode), minimal and maximal reactive power which ensures generators operation in accordance with [4], reactive power in-feed at PCC (if measurements at PCC are not available, unit's reactive power consumption, step-up transformer and line losses should be subtracted from the generated reactive power) gives full set of information needed for system control. These data should be adjusted to format requested by power system stability software and power system optimal operation software (different optimization criteria or market demand, 15 minute ahead forecast). Slow acting Q reserve $Q_{i\,min/max\_slow}$ at generator terminals are given by (3) and (4)

$$Q_{i\min\_slow} = \max \begin{cases} Q_{i\min} & \text{by } P\text{-}Q \text{ chart for } P_i \\ Q_{i\min} & \text{for } V_{ti\min} \\ Q_{i\min} & \text{for operational requests} \end{cases}, \quad (3)$$

$$Q_{i\max\_slow} = \min \begin{cases} Q_{i\max} & \text{by } P\text{-}Q \text{ chart for } P_i \\ Q_{i\max} & \text{for } V_{ti\max} \\ Q_{i\max} & \text{for operational requests} \end{cases}. \quad (4)$$

Slow acting Q reserve Q_{i_PCCmin/max_slow} is either measured at PCC or calculated from terminal measurements by subtracting losses Q_{i_LOSS} from generator terminals to PCC i.e. auxiliary equipment consumption, step-up transformer losses, line losses, (5) and (6):

$$Q_{i\_PCC\min\_slow} = Q_{i\min\_slow} - Q_{i\_LOSS} \quad (5)$$

$$Q_{i\_PCC\max\_slow} = Q_{i\max\_slow} - Q_{i\_LOSS} \quad (6)$$

The maximum Q reserve (uniformly distributed among the plant generators) and updated Q limits of each generator (considering actual generated active power and network voltage) are the best support that power plant can provide to the power system regarding operation and stability of power system. These power plant data allow TSO to run power system optimally, safely and reliably. The next step is to allow TSO an insight into power plant additional costs related to Q generation. This is facilitated by basic CQVC operation leading to equal use of percentage of the available Q of each SG involved. The influence of generated active power and plant's busbar voltage on reactive power limits is taken into account in real time.

The proposed algorithm is installed at CQVC which provides maximum voltage support from power plant to power system. The shortcoming of this t ype of Q allocation among generators in the plant is non-uniform distribution of temperatures across generators which are differently loaded. Thus, in deregulated environment, the plants are forced to operate in a manner which ensures maximization of equipment's operating life and costs minimization. The solution is in the good price policy which recognizes reactive power as a market good.

4. COST OF REACTIVE POWER GENERATION AND ACHIEVABLE PRICE

The costs of reactive power generation are divided into capital costs and Q generation costs. The capital costs, including the capacity cost, are aggregated in cost coefficients C1, Fig. 4. [15], [16]. This cost should be reimbursed to energy producer irrespectively weather the TSO uses the voltage ancillary service or not. The several production costs are strongly related to Q generation and thus should be directly linked with generated MVAr.

Region 1 is where in-feed of reactive power from generator to PCC is equal or less than zero. Certain generator should not be additionally reimbursed for additional costs because it does not supply any Q to the system although it participates in voltage control. Region 2 is associated with additional heating and lowering of operational exploitation life [14]. The reactive power is delivered to the system, voltage support is performed, the fuel price is negligible so the generator owner should be compensated for accelerated aging. In region 3, Q generation is enabled by generators who missed the opportunity to sell real power. The expenses of Q generation in this region are undisputed. Region 4 is connected with absorption of excess Q from power system and again additional localized heating.

The operating SG's regions and associated price coefficient in real time can be communicated to TSO

by CQVC, see Fig. 5. To make the proper valorisation of reactive power generated by SG it is necessary to have real time information about SG's operating region depicted in Fig. 7 and facilitated by CQVC operation and measurements. These costs should be corrected considering power plant location in the system and losses associated with local (plant) Q requirement due to real power transfer through the system. Finally the market coefficient that reflects actual offer/demand conditions can be applied to finely tune the reactive power price.

In addition, [17] suggests payment according reactive power and voltage availability. This also could be performed by CQVC as plant integrating device, regarding variables of interests for network voltage support as the ancillary service. Q allocation among generators in the power plant is already inherentl y performed by CQVC by appropriate weighting across available range of voltage and reactive power reserve. Hence CQVC could be used as new voltage ancillary service meter.

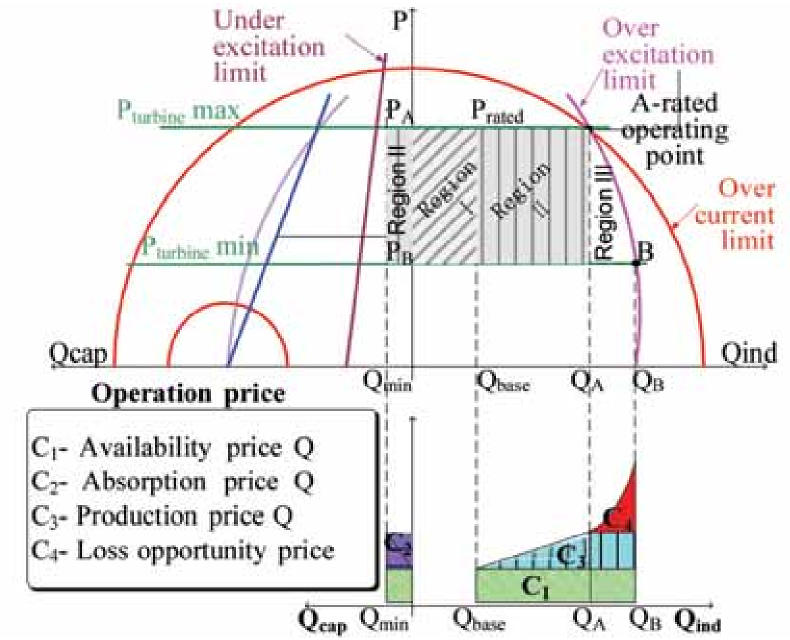

Fig. 7 Reactive power production cost regions considering generator capability

5. CONCLUSIONS

The smart control devices in power plants allow integration of opposite requirements into unique control algorithm. These advantages, combined with market impact and strong communication connecting all participants, enable qualitatively new approach to power system voltage and reactive power flow control. The proper validation and pricing of ancillary services, as it is the reactive power production, is of utmost importance to secure the power system operational security and the proper availability of reactive power.

This paper proposes and discusses the algorithm for real time monitoring of reactive power reserve of synchronous generators. The algorithm is implemented in CQVC that has been installed in the two largest steam power plants in Serbia in 2011. The CQVC offers the variety of additional functions that power plant, power system and finally power consumers could benefit from including more uniform ageing of generators, better HV busbar voltage control, uniform reactive power allocation and assessment of costs of reactive power deployment. Finally, it is worth emphasising that the CQVC concept is equally applicable to control and monitoring of group of distributed generators or any type of renewable power sources connected to local voltage control area.

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3-03

IMPLEMENTATION OF RESERVE TRADING IN SMM ENTSO-E CONTROL BLOCK

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SUMMARY

In coordination with ENTSO-E and Energy Community, the balancing market with exchange of reserves is developed in SEE region. The first step in development of balancing market implemented within SMM control block is tertiary (replacement) reserve trade. In this paper authors will present current implementation of reserve trading within SMM (Serbia, Macedonia, Montenegro) ENTSO-E control block, and also the plans for future development of reserve trading system within the control block. Authors will present both principles of replacement reserve trading within the software support for replacement reserve trading implemented within SMM LFC block controller system in Serbian National Control Center (Serbian TSO is a block coordinator). At the end of paper the authors will briefly present ongoing activities and future plans for further implementation of reserve trading, including the secondary reserve trading.

KEYWORDS

Reserve trading, ENTSO-E control block, software implementation

1. INTRODUCTION

During the last two decades the European energy sector passed through a lot of changes. Unbundling and the permanent development of the European energy market raised, among the others, the question of cross border exchange of reserves. The problem is difficult and still not completely solved. If someone wants to exchange the energy across the border between two TSOs, he will need free cross-border capacity on the connecting tie-lines. When purchasing reserve TSO wants to have full access to the reserve during the whole period of the contract validity. Consequently, if TSO wants to buy for example a tertiary reserve in the neighbouring country it has to reserve cross border capacity in the amount of purchased reserve. That means that the reserved capacity will remain unused, except for the periods when the reserve is activated. And that could or could not happen. On the congested borders that mean that the capacity available for the market will be additionally reduced because of the possible exchange of reserve that could or could not happened. The result is that, at the moment, European TSOs does not exchange large amount of reserves.

The exchange a primary reserve is most developed one, since energy activated in primary reserve uses Transmission Reliability Margin (TRM) between two TSOs and not the cross-border available capacity. In a way GCC (Grid Control Calculation) is a kind of cross-border exchange of secondary reserve. But even in GCC, real-time exchange programs between two TSOs could be established only if there is available transmission capacity.

One of the main tasks of the most important European energy organizations (ENTSO-E, ACER...) is a constant development of the European energy market. And as a part of this task is a development and increase of cross-border exchange of reserves. Future introduction of Network Codes should incentivize TSOs to develop the procedures in order to exchange the active power reserves.

2. RESERVE TRADE IN SMM BLOCK

Serbian TSO, JP EMS, is responsible for the operation of the transmission network in Serbia. JP EMS has to closely follow the European rules of network operation, since the Serbian network is an integral part of the interconnection Continental Europe and JP EMS is a member of ENTSO-e. According to that rules, TSOs are allowed to fulfil some obligations together if they create a Control Block (CB). At the beginning of the last decade of the previous century JP EMS, together with MEPSO (FYR Macedonia TSO) and CGES (Montenegrin TSO), created a control block (JIEL). In 2007 the block has been reorganized and named SMM (Serbia, Macedonia and Montenegro).

Few years ago, SMM CB members decided to prepare for the period when Network codes will become operational and to explore possible benefits. The most obvious one was the fact that the amount of necessary active power reserves will in the future be calculated on the control block level. That means that each control block member will be able to reduce the purchased amount of reserves and consequently reduce costs. The prerequisite is, of course, the opening of possibility for SMM CB TSOs to exchange the reserves among them. If TSOs decides to calculate the amount of necessary reserve on the level of control block, then the whole amount of the reserve should be available for each TSO all the time.

The work has started in 2014, and in April 2015 PE EMS and CGES signed the contract about cross border exchange of tertiary reserves. For the time being, MEPSO does not participate in the exchange of tertiary reserve due to some regulatory problems. It is expected that MEPSO is going to solve problems and sign the contract with CGES and JP EMS until the end of 2016.

Since the contract between PE EMS and CGES is just the first step, two TSOs are now able to exchange just their surpluses of tertiary reserve. The precondition is that there is enough available transmission capacity between Serbia and Montenegro, what is usually the case.

During the preparations for the implementation of the contract, PE EMS has fully automatized the process of activation of cross-border exchange of reserve. The software that reduces the effort of dispatchers and the possibility of error has been developed and LFC program has been modified accordingly.

3. LFC/SMM CONTROL SYSTEM

When, at the end of 2007, Serbian TSO have taken over the coordination of joint billing and control block of Electric Power Industries of Serbia, Montenegro and Macedonia (ENTSO-E SMM control block) new control system with new software organization and functions were introduced as described in [1, 2].

Major functions of this control system are:

- Simultaneous calculation of area control errors (ACE's) for all members of SMM block (Serbia, Macedonia and Montenegro) and for a SMM block as a whole.
- Tracking interchange, compensation and frequency schedules for all block members.
- Tracking of all relevant data for control block performance assessment and billing calculation (performed by integrated energy accounting system). Those data are retrieved from ETSO scheduling and Market Management System via Serbian TSO Energy Accounting System.
- Providing all data to be sent to ENTSO-E Energy Awareness System (EAS).

- Provides interfaces with SCADA/EMS system and other relevant information systems in Serbian TSO.
- Provides user interfaces for control block operators.
- It also interfaces, indirectly through SCADA/EMS system, with other block members control centres by using IEC 60870-6 TASE2 (ICCP) protocol.
- SMM LFC block controller does not perform direct control of regulating units (sending raise/lower pulses) but relies on individual member TSO's SCADA/EMS system to perform these actions instead.

The SMM block controller is directly coupled and share same configuration database with the AGC controller for Serbian TSO which provides functions like:

- All standard AGC functions:
  - Unit control module (which may be set point or raise-lower pulse based)
  - Independent ACE calculation, in addition to ACE calculation performed by block controller.
  - Proportional-Integral (PI) control module
  - Alarm processing and generation, etc.
- Control performance assessment, including calculation, tracking of frequency quality indices.
- Primary, secondary and tertiary reserve tracking, evaluation and reporting.
- Scheduling functions and related schedule database are expanded in order to support reserve scheduling and modelling.
- Database and software support for reserve sharing and market functions.
- Virtual tie-lines and virtual generation are now supported (but still not used, except experimentally, since those are intended for future reserve and control sharing in line with future market rules).

Figure 1 describes architecture of SCADA/EMS elements related to AGC/Block controller operation. Other SCADA/EMS elements are not shown.

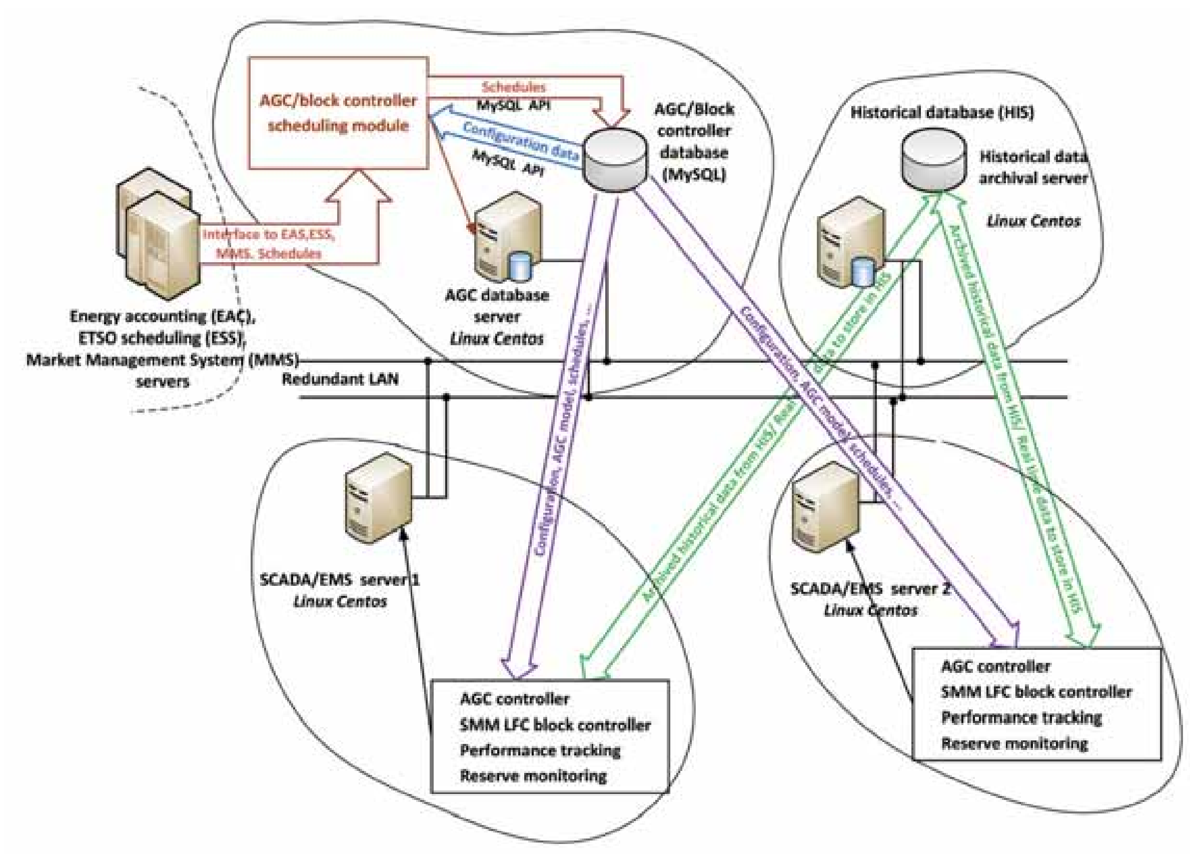

Figure 1 Overview of SMM LFC block controller system architecture

AGC and block controller use dedicated database server for configuration, model and scheduling data, where AGC/block controller scheduling module interfaces with external Energy Accounting System (EAC), ETSO Scheduling System (ESS) and Market Management System (MMS). Those external information systems are source of scheduling data in normal real-time operation. In case of failure scheduling data may be entered manually by operator via dedicated user interface. All retrieved (or manually entered) scheduling data are stored in relational database, from where they can be accessed by other software modules.

Real-time AGC control, SMM LFC block controller, performance tracking and reserve monitoring modules are installed at dual redundant SCADA/EMS servers, and are directly coupled with SCADA kernel. They (particularly performance tracking and reserve monitoring modules) also interface with historical database (HIS) on historical data archival server, from where they obtain data needed for performance calculations and similar tasks.

All servers are using 64-bit Linux OS (Centos 6.x), which is chosen in preference to Microsoft Windows due expected better stability and shorter interruptions of service, open-source model which enables system developers to, for example, access driver sources and identify, debug and even correct some problems without waiting for driver vendor to provide solutions. Particular Linux distribution (Centos 6.x) was chosen because it is based on, and 100% compatible with, Red Hat Enterprise Linux which is perceived as extremely stable and "industrial grade". All server applications (AGC, block controller, SCADA, network applications) are developed using programing languages C and C++. HMI applications are developed using Java 1.7 and C++ with Qt 4.x cross-platform framework. Java and Qt are chosen for development of HMI in order to provide cross-platform compatibility and easy porting to both Linux and Windows. In standard configuration all operator stations (not shown at figure 1.) are Microsoft Windows based. Such configuration enables operators to use at same station both SCADA/EMS HMI and standard Office and other tools they are familiar with.

4. ACTIVATION OF TERIARY RESERVE OFFERS

PE EMS has developed a software application that helps dispatchers during the process of cross border activation of tertiary reserve. It also automatize of preparation of PE EMS tertiary reserve offers and their sending to CGES.

On the day D, at 16:00 application sends a tertiary reserve offer to CGES for the whole day D+1. This offer is just indicative and can be changed 30 min before the beginning of the hour. So, the offer for the available tertiary reserve between 12:00 and 13:00 can be modified until 11:30. After 11:30 that offer becomes mandatory

When PE EMS decides to activate tertiary reserve in Montenegro, the procedure starts with phone conversation of two TSOs dispatchers. Then PE EMS dispatcher enters the transaction data into the dedicated application. Application checks are the entered values complaint with the offer and if the total energy exchanged during the hour is a whole number. If everything is good, application creates Reserve activation request in PDF format and CSV file with the data that describes the activated tertiary reserve. Those two documents are automatically sent to CGES and to a number of predefined e-mail addresses.

CGES dispatcher signs the Reserve activation request and sends it back PE EMS. He also sends files in PDF and CSV format. PE EMS software imports data from CSV file. After that everything is ready for the activation of the tertiary reserve. With one push of the button, PE EMS dispatcher activates the tertiary reserve. Application sends the information about the activated reserve to the predefined mailing list. It also sends the change of the exchange program to the PE EMS accounting EAS database. From EAS database the new exchange program is sent to SCADA/EMS system and AGC application.

If CGES activates the reserve in Serbia, the procedure is similar. CGES sends to PE EMS PDF and CSV files and PE EMS application import data from CSV file. Application sends the information about the activated reserve to the predefined mailing list and to the EAS database.

5. IMPLEMENTATION OF TERTIARY (REPLACEMENT) RESERVE SHARING MECHANISM

In operation without tertiary reserve sharing SMM block controller calculates area control errors (ACE's) for each control block member as:

$$ACE_k = (P_k - P_{k0}) + B_{fk}(f - f_k) \qquad (1)$$

Symbols used in above equation (1) are:

ACE –Area control error of k-th control area in SMM block

P_k – Net interchange of k-th control area

P_{k0} – Effective net interchange schedule of k-th control area

B_{fk} – Area frequency regulation constant

f – Actual (measured) frequency

f_0 – Scheduled frequency

Equation (1) is used when SMM block controller operate in so called "*pluralistic mode*". SMM block controller may also operate in "*hierarchical mode*" when area control errors for each participating member are augmented with additional component proportional to whole SMM block ACE:

$$ACE_k = (P_k - P_{k0}) + B_{fk}(f - f_k) + h_k ACE_{SMM} \qquad (2)$$

In above equation h_k is hierarchical regulation participation coefficient of k-th member company, and it is always:

$$\sum_k h_k = 1 \qquad (3)$$

Whole SMM block ACE is calculated as:

$$ACE_{SMM} = (P_{SMM} - P_{SMM0}) + B_{fSMM}(f - f_0) = \sum_k (P_k - P_{k0}) + \sum_k B_{fk}(f - f_0) \qquad (4)$$

Hierarchical control mode is usually not used in normal SMM block operation.

Effective net interchange schedule P_{k0} consists of three components

$$P_{k0} = S_{k0} + C_{k0} + R_{k0} \qquad (5)$$

Symbols used in above equation (5) are:

S_{k0} – Interchange schedule without compensation and ramping

C_{k0} – Compensation schedule

R_{k0} – Part due to schedule ramping which starts at some predefined time *T* before end of schedule cycle and ends after period T in new schedule cycle (if 1 hour schedule cycle is used then T is usually set to 5 min) as illustrated in figure 2.

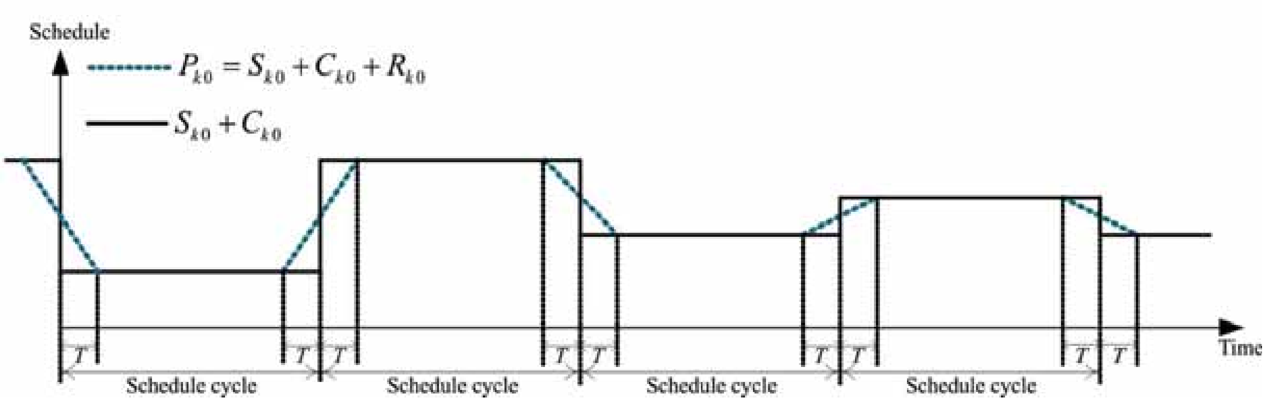

Figure 2. Illustration of schedule "ramping"

Tertiary reserve sharing is implemented in by introducing the "*Interchange Schedule Offsets*", that is effective interchange is augmented with additional component $\Delta P_{TR,k}$ due to tertiary reserve sharing (6).

$$P^*_{k0} = P_{k0} + \Delta P_{TR,k} \tag{6}$$

Value P_{k0} is then used for all ACE calculations instead of P_{k0}. Usually interchange schedule offsets $\Delta P_{TR,k}$ have much smaller values than respective P_{k0} so they are not additionally "ramped" (Figure 3).

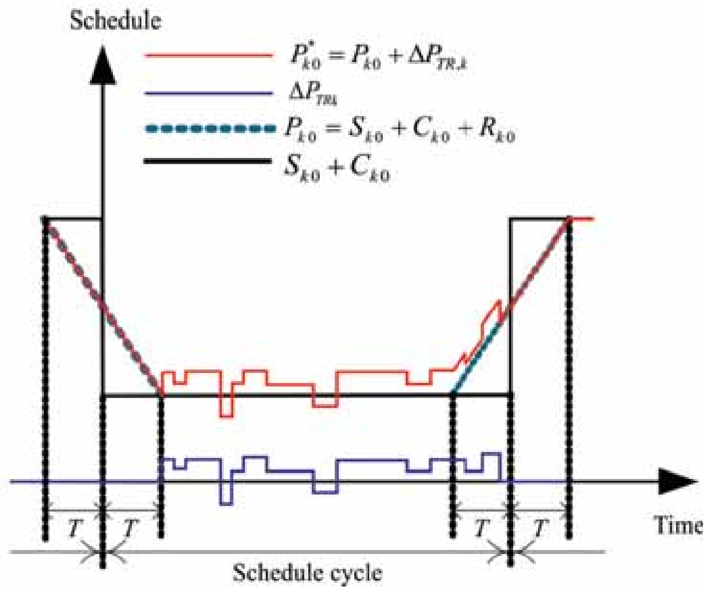

Figure 3. Interchange schedule with component for tertiary reserve trade

If all tertiary reserve sharing/trading is performed within SMM block (i.e. there is no reserve sharing with control areas outside control block) then value block area control error ACE_{SMM} is unaffected by reserve sharing because it is always

$$\sum_k \Delta P_{TR,k} = 0 \tag{7}$$

when sharing is performed only within control block (k denotes k-th SMM block member).

That means that change of exchange program between two TSOs within the same control block does not influence the exchange program of the whole control block towards the rest of the interconnection. Consequently there is no need to declare change to the Continental Europe interconnection.

Interchange schedule offsets are scheduled in shorter time frames (currently 5 min) than regular interchange schedules (1 hour or 15 min). Interchange schedule offsets are provided by EAS database in the form of CSV files. Those files contain 288 ofsets (for every 5 minute interval) for each block member, for each UTC day present in schedule file.

These files are sent by means of automated SFTP (*Secure FTP*) script to server hosting AGC/SMM block controller database (AGC database server shown at figure 1). At AGC database server dedicated loader application checks every 60 seconds if new interchange offset schedules file is available, and if available it is loaded automatically. Load procedure discards all schedules in past, and for current 5 min interval, only schedules for future time intervals are imported.

Dispatchers may use standard AGC scheduling HMI to inspect imported values for interchange offsets (as shown at Figure 4). In case that, for any reason, CSV files with offsets became unavailable or corrupted, dispatchers may use AGC scheduling HMI for manual entry of schedules. In case of prolonged unavailability of this or other schedules appropriate SCADA alarms are automatically issued.

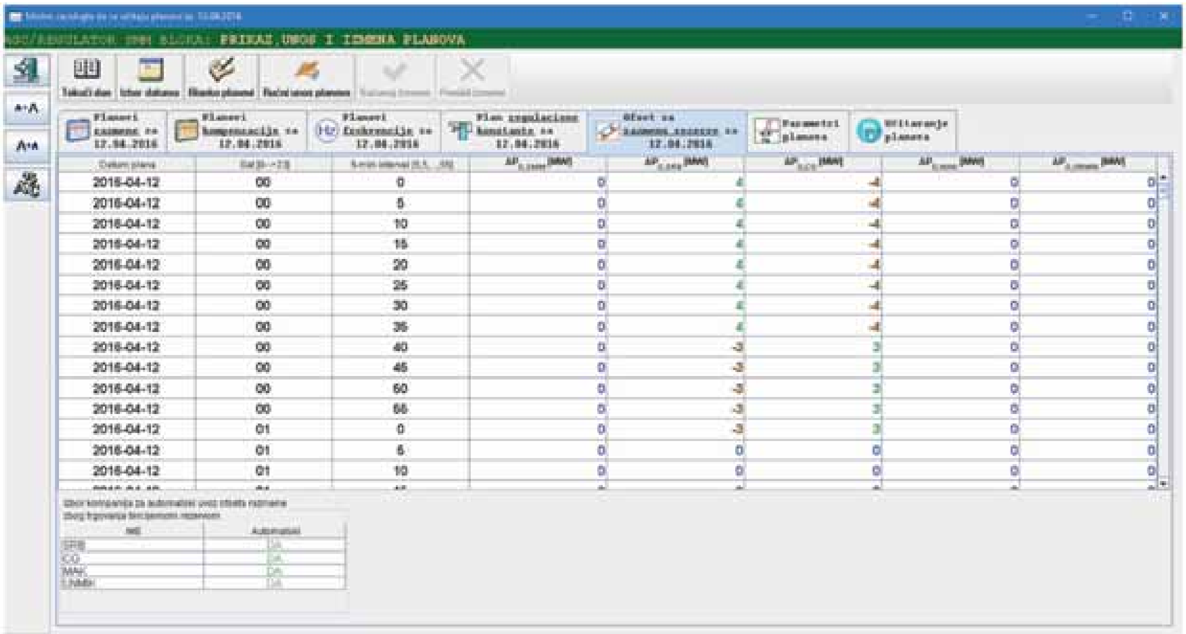

Figure 4 Interchange schedule offsets due to tertiary reserve trade overview in AGC scheduling GUI

Dispatchers may control if those offsets are used by turning them on or off at appropriate AGC&SMM block controller HMI.

6. CONCLUSION

Paper describes the new procedure that allows Serbian (PE EMS) and Montenegrin (CGES) TSO to exchange tertiary reserve. TSOs are motivated by the new European Network Codes that allow calculation of necessary reserve on the control block level. The prerequisite is that control block members are able to exchange reserves among themselves. For the time being, only two members of SMM control block are able to exchange tertiary reserve. Macedonia has to solve some regulatory issues before to join the process. The paper describes the newly developed software and its modifications that allow smooth functioning of the procedure/mechanism.

The reserve exchange started in April 2015 and during the first year of operation tertiary reserve exchange flowed smoothly across the border allowing both TSOs to maintain the security of their system.

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Dušan Arnautović
(1950 – 2016)

Dušan Arnautović je rođen 28. marta 1950. godine u Beogradu. Osmogodišnju školu i gimnaziju je završio u Beogradu. Diplomirao je 1973. gdine na Elektrotehničkom fakultetu u Beogradu - Energetski odsek, gde je od 1975. godine bio zaposlen kao stažer na Katedri za postrojenja električne snage, i to kao stipendista Republičke zajednice za naučni rad za usavršavanje uz rad.

Posle dve godine rada na fakultetu, 1977. godine zapošljava se u Elektrotehničkom institutu "Nikola Tesla" u Beogradu i od tada počinje njegov profesionalni uspon i period značajnih naučno-istraživačkih ostvarenja. Prvo je na Elektrotehničkom fakultetu u Beogradu 1978. godine odbranom magistarskog rada *"Jedan postupak analize stabilnosti složenih energetskih sistema primenom direktne metode Ljapunova"* završio postdiplomske studije na smeru Upravljanje energetskim sistemima. Naučno zvanje istraživač - saradnik stekao 1985. godine u Elektrotehničkom Institutu "Nikola Tesla". U toku 1985. godine bio je prvi put na stručnom usavršavanju u inostranstvu na University of Illinois, Urbana, SAD (tema usavršavanja - metode projektovanja regulatora u elektroenergetskim sistemima).

Titulu doktora tehničkih nauka za oblast elektrotehnike stekao jula 1988. godine na Elektrotehničkom fakultetu u Beogradu odbranom doktorske disertacije *"Sinteza multivarijabilnih regulatora pobude u višemašinskim elektroenergetskim sistemima primenom metode projekcionih upravljanja"*. Jula 1989. godine stekao naučno-istraživačko zvanje naučni saradnik, a 19. aprila 1995. godine zvanje višeg naučnog saradnika. U toku 1990. godine bio drugi put na specijalizaciji u inostranstvu na Rutgers University i University of Illinois, SAD (tema specijalizacije - primena savremenih metoda automatskog upravljanja u elektroenergetskim objektima). Od 1991. godine, sve do svoje iznenadne smrti, bio je na funkciji direktora Centra za automatiku i regulaciju u Elektrotehničkom institutu „Nikola Tesla".

Već na samom početku svoje karijere, dr Dušan Arnautović je počeo da sarađuje sa CIGRE. Svoj prvi rad o analognim modelima za podešavanje turbinskih regulatora za CIGRE je napisao 1979. godine za 14. savetovanje (tada) JUKO CIGRE koje je održano u Sarajevu. Od tada gotovo da nije bilo domaćeg savetovanja CIGRE na kojem nije bio i neki rad dr Dušana Arnautovića (kao autora ili koautora). Poslednjih godina dr Dušan Arnautović se više aktivirao na pisanju radova za međunarodnu organizaciju CIGRE u Parizu. Njegovi radovi su uvršteni u rad 42. savetovanja (2008), 45. savetovanja (2014) i ove, 2016. godine, na 46. savetovanju međunarodne CIGRE u Parizu biće uključen rad *"Real time synchronous generator dynamic reactive reserve monitoring by coordinated reactive power voltage controller"* gde je dr Dušan Arnautović jedan od koautora.

Pored pisanja radova, dr Dušan Arnautović je bio aktivan član Studijskih komiteta CIGRE. Na domaćem planu, bio je dugogodišnji član Studijskog komiteta A1 - Obrtne električne mašine i Studijskog komiteta B4 - HVDC i energetska elektronika, a na međunarodnom planu od 2010. godine bio je član-posmatrač međunarodnog Studijskog komiteta A1 za obrtne električne mašine. U jednom periodu rada CIGRE Srbija bio je član Nadzornog odbora. Njegova iznenadna i prerana smrt zadesila ga je na funkciji člana Izvršnog odbora CIGRE Srbija i predsednika Studijskog komiteta A1 CIGRE Srbija, na koju je izabran 2011. godine.

S velikom zahvalnošću i poštovanjem čuvaćemo uspomenu na dr Dušana Arnautovića, kao izuzetnog stručnjaka u oblasti elektroenergetike, ali pre svega kao iskrenog, vrednog i dragocenog čoveka i člana CIGRE Srbija.

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