



UNIVERZITET CRNE GORE MAŠINSKI FAKULTET PODGORICA



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Broj: 2723
Podgorica, 21.10.2021.

UNIVERZITET CRNE GORE
CENTAR ZA DOKTORSKE STUDIJE

U prilogu dopisa Vam dostavljamo Prijedlog odluke Vijeća Mašinskog fakulteta, sa sjednice održane dana 21.10.2021. godine o predlaganju formiranja komisije za odbranu polaznih istraživanja i ocjenu podobnosti doktorske teme i kandidata mr Borisa Hrnčića.



DEKAN,

Prof. dr Igor Vušanović



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Broj: 2722

Podgorica, 20.10.2021. godine

Na osnovu člana 64. Statuta Univerziteta Crne Gore, u vezi sa članom 26 i 27 Pravila doktorskih studija, Vijeće Mašinskog fakulteta u Podgorici, na sjednici održanoj elektronskim putem, dana 20.10.2021. godine, utvrdilo je prijedlog

ODLUKE

o formiranju Komisije za odbranu polaznih istraživanja
i ocjenu podobnosti doktorske teze i kandidata

I Formira se komisija za odbranu polaznih istraživanja i ocjenu podobnosti doktorske teze pod nazivom „Metamodeliranje energetskeg odziva zgrada i višekriterijumska optimizacija sa aspekta poboljšanja energetske performansi“ kandidata Borisa Hrnčića, u sastavu:

1. Prof. dr Vladan Ivanović, predsjednik
2. Prof. dr Igor Vušanović, mentor
3. Dr Vedran Perić, komentor
4. Doc. dr Milan Šekularac, član
5. Doc. dr Esad Tombarević, član

II Odluka stupa na snagu kad je verifikuje Senat Univerziteta Crne Gore.

DEKAN
Prof. dr Igor Vušanović

Dostaviti:

- članovima Komisije
- centru za doktorske studije Univerziteta
- Borisu Hrnčiću
- Predsjedniku komisije za doktorske studije
- a/a

UNIVERZITET CRNE GORE
Mašinski fakultet
Komisija za doktorske studije
Podgorica, 19. 10. 2021.
Br. 2680

- VIJEĆE MAŠINSKOG FAKULTETA -

Poštovani,

U skladu sa Pravilima doktorskih studija, u prilogu dostavljamo prijavu kolege **Borisa Hrnčića** na predviđenom **obrascu PD**, kao i prateću dokumentaciju.

Komisija za doktorske studije na Mašinskom fakultetu je na elektronskoj sjednici održanoj dana 13. 10. 2021. godine, razmatrala formalne uslove dostavljene prijave, sa stanovišta neophodnih podataka i ispunjavanju uslova za prijavu teze, i poštujući princip kompetentnosti, imajući u vidu dostavljenu prijavu i prateći materijal, inicira sledeći sastav komisije za odbranu polaznih istraživanja i ocjenu podobnosti teme i kandidata:

1. Prof. dr Vladan Ivanović, predsjednik
2. Prof. dr Igor Vušanović, mentor
3. Dr Vedran Perić, komentor
4. Doc. dr Milan Šekularac, član i
5. Doc. dr Esad Tombarević, član.

Predlažemo Vijeću Mašinskog fakulteta da na bazi ovog inicijalnog predloga, utvrdi predlog sastava komisije i isti dostavi Odboru za doktorske studije na dalje postupanje.

Srdačno,

PREDSJEDNIK KOMISIJE ZA
DOKTORSKE STUDIJE


Prof. dr Aleksandar Vujović



Primiteno	08.10.21		
Org. jed.	Broj	Prilog	Vrednost
	258		Obrazac

PRIJAVA TEME DOKTORSKE DISERTACIJE

OPŠTI PODACI O DOKTORANDU	
Titula, ime i prezime	Mr Boris Hrnčić, spec.sci. mašinstva
Fakultet	Mašinski fakultet
Studijski program	Mašinstvo
Broj indeksa	1/2020
Ime i prezime roditelja	Goran Hrnčić
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BIOGRAFIJA I BIBLIOGRAFIJA	
Obrazovanje	Magistar mašinstva, Mašinski fakultet u Podgorici - Univerzitet Crne Gore, 28.09.2020. godine, (10). Spec.sci. mašinstva, Mašinski fakultet u Podgorici - Univerzitet Crne Gore, 16.07.2019. godine, (9,25). BsC mašinstva, Mašinski fakultet u Podgorici - Univerzitet Crne Gore, 06.07.2018. godine, (8,41).
Radno iskustvo	Novembar 2019. – danas - Saradnik u nastavi na predmetima iz oblasti termotehnike i termoenergetike, Univerzitet Crne Gore, Mašinski fakultet u Podgorici. Januar 2019. – Oktobar 2019. – Pripravnik - Stručno osposobljavanje lica sa stečenim visokim obrazovanjem, Univerzitet Crne Gore, Mašinski fakultet u Podgorici
Popis radova	Radovi na SCI/SCIE listi: [1] B. Hrnčić , A. Pfeifer, F. Jurić, N. Duić, V. Ivanović, I. Vušanović. Different investment dynamics in energy transition towards a 100% renewable energy system. <i>Energy</i> . 2021; 237 - 121526 https://doi.org/10.1016/j.energy.2021.121526 Radovi na konferencijama: [2] B. Hrnčić , A. Pfeifer, V. Ivanović, I. Vušanović, Energy Transition Towards Achieving a 100% Renewable Energy System: Case Study of Montenegro, 4th SEESDEWES, Sarajevo, Bosnia and Herzegovina, Jun 28 th – July 02 nd , 2020.
NASLOV PREDLOŽENE TEME	
Na službenom jeziku	Metamodeliranje energetskog odziva zgrada i višekriterijumska optimizacija sa aspekta poboljšanja energetskih performansi
Na engleskom jeziku	Metamodeling of building energy response and multiobjective optimization from the aspect of energy performance improvement

Obrazloženje teme

Sektor zgradarstva u svijetu ima udio od skoro 40% u ukupnoj potrošnji energije i ukupnoj emisiji ugljen-dioksida (CO₂). Ovakav udio u potrošnji energije i emisiji CO₂ čini sektor zgradarstva štetnijim po životnu sredinu od pojedinačno bilo kojeg drugog energetske zavisnog sektora. Zbog problema koje donosi globalno zagrijavanje sve više zemalja na svijetu uvodi zakonske regulative koje se tiču smanjenja emisije gasova staklene bašte (GHG) i postizanja karbonske neutralnosti. Evropska komisija je u decembru 2019. godine kroz „European Green Deal“ postavila ambiciozan cilj da do 2050. godine sve evropske države dostignu nultu emisiju CO₂ čime bi Evropa postala prvi klimatski neutralan kontinent. Prema planu postizanja klimatske neutralnosti neophodno je ispuniti dva uslova. Prvi uslov je smanjenje ukupne potrošnje energije, a drugi uslov je zamjena fosilnih goriva sa obnovljivim izvorima energije.

Da bi se ovi uslovi mogli ispuniti u sektoru zgradarstva, pored mnogih drugih, neophodna je upotreba složenih matematičkih modela i kompjuterskih alata koji služe za predviđanje i optimizaciju potrošnje energije u zgradama. Matematički modeli koji služe za proračun potrošnje energije u zgradama se mogu podijeliti na statičke i na dinamičke. Statički modeli ne zahtijevaju značajno korišćenje kompjuterskih resursa, ali u odnosu na dinamičke modele imaju manju tačnost proračuna i ne mogu se koristiti za detaljnu analizu implementacije obnovljivih izvora energije u ovom sektoru.

Razvijanje brzih dinamičkih modela za proračun potrošnje energije u kombinaciji sa optimizacionim modelima će biti ključno za ispunjavanje ciljeva dekarbonizacije sektora zgradarstva.

Pregled istraživanja
1. Uticaj termofizičkih osobina omotača zgrada na potrošnju energije:

Reilly i Kinnane (2017) su ispitali uticaj toplotne mase (toplotnog kapaciteta) zidova na potrošnju energije u zgradama u slučajevima hladne klime u kojoj se aktivno koristi sistem grijanja i slučajevima tople klime u kojoj se aktivno koristi sistem hlađenja. Došli su do zaključka da bi velika toplotna masa zidova u hladnim klimama često mogla da dovede do veće potrošnje energije u odnosu na zidove sa manjom toplotnom masom, zbog povezanosti vremena rada sistema grijanja sa boravkom ljudi u prostoru. **Ghoreishi (2019)** je ispitao uticaj toplotne mase zidova na potrošnju energije u 8 američkih gradova. Povećanje toplotne mase spoljašnjih zidova je imalo uticaja na smanjenje potrošnje energije potrebne za grijanje u svih osam gradova, dok je u zavisnosti od klime u nekim gradovima povećanje toplotne mase dovelo do povećanja potrošnje energije potrebne za hlađenje. **Sharaf (2020)** je u svom radu ispitao uticaj toplotne mase zidova na potrošnju energije u zgradama u klimatskim uslovima koji vladaju u gradu Al Mafraq u Jordanu. Ispitivanje je vršeno kroz mjerenje unutrašnje temperature prostora zimi i ljeti u dvije različite zgrade od čega jedna zgrada bila sazidana od betonskih blokova, a druga zgrada je bila napravljena od glinenih zidova. Pokazalo se da se u zgradi koja ima glinene zidove temperatura držala u granicama ljudskog komfora za razliku od zgrade za zidovima od betonskih blokova iz čega se zaključilo da zgrade koje imaju veliku masu zidova imaju manju potrebu za potrošnjom energije. **Kuczyński i Staszczuk (2020)** su sproveli eksperimentalno istraživanje u Poljskoj u gradu Zielona-Gora. Istraživanje je izvršeno u avgustu na dvije identične kuće koje su se razlikovale samo po težini svoje konstrukcije. Prva kuća je imala laku konstrukciju, a druga kuća je imala tradicionalnu zidanu konstrukciju. Rezultati istraživanja su pokazali se da bi potrošnja energije bila manja u kući koja ima veću težinu konstrukcije. **Sharston i Murray (2019)** su ispitali pojedinačne efekte toplotne mase i debljine izolacije za zgradu u 8 različitih klimatskih zona u SAD primjenom softvera EnergyPlus. Pokazalo se da u hladnijim klimama povećanje debljine izolacije ima veći uticaj na smanjenje potrošnje energije u odnosu na povećanje toplotne mase zidova, dok je kod toplijih klimatskih zona situacija bila obrnuta.

U radu **(Zhang i dr., 2017)** je prikazano istraživanje o primjeni reflektivnih premaza na spoljašnje

zidove zgrade u cilju smanjenja potrošnje energije koja je potrebna za hlađenje na primjeru zgrade u klimatskim uslovima Čengdua. Istraživanje je pokazalo da bi primjena reflektivnih premaza smanjila prosječnu unutrašnju temperaturu vazduha za 2,4 stepena, što bi donijelo uštedu u potrošnji električne energije od oko 15% u sezoni hlađenja.

U radu (**Souto i dr., 2020**) je prikazano ispitivanje uticaja različitih koeficijenata solarne refleksivnosti fasada zgrada na potrošnju energije u različitim klimatskim zonama. Rezultati su pokazali da bi se optimalnim odabirom solarne refleksivnosti mogle postići prijatnije temperature unutrašnjeg vazduha ukoliko zgrada nema sistema grijanja i hlađenja, a u slučaju da sistem grijanja i hlađenja postoji, mogla bi se postići ušteda od 32% u potrošnji energije koja je potrebna za grijanje i hlađenje prostora. Ispitivanje mogućnosti uštede energije primjenom premaza za fasade, sa promjenjivom solarnom refleksivnošću i u zavisnosti od vremenskih uslova u četiri klimatske zone u SAD je prikazano u radu **Parka i Krartija (2016)**. Istraživanje je pokazalo da bi se primjenom ovih premaza mogla ostvariti ušteda od 11% u ukupnoj potrošnji energiji potrebnoj za grijanje i hlađenje.

Almarzouq i Sakhrieh (2018) su predstavili istraživanje uticaja primjene različitih vrsta prozora na potrošnju energije i osjećaj toplotne ugodnosti u zgradama u klimatskim uslovima Ammana u Jordanu. Rezultati su pokazali da bi se zamjenom prozora sa jednostrukim staklom za prozor sa dvostrukim staklom ispunjenim argonom i premazom sa niskom emisivnošću mogla napraviti ušteda u potrošnji energije 24,7%, dok bi se osjećaj toplotne ugodnosti smanjio za 1%. U radu

Alama i Islama (2017) ispitan je odabir najpogodnije vrste prozora za minimalizaciju potrošnje energije, na primjeru stambene zgrade u gradu Jessore u Bangladešu. Pokazalo se da bi se pravilnim odabirom stakala i elemenata koji bacaju sjenku na staklo mogla napraviti velika ušteda u potrošnji energije na godišnjem nivou. (**Detsi i dr., 2020**) su ispitali mogućnost uštede energije potrebne za grijanje, hlađenje i rasvjetu u slučaju primjene 6 različitih kombinacija premaza za prozore sa trostrukim zastakljenjem za klimatske uslove Atine i Stokholma. Rezultati su pokazali da bi se kombinacijom elektrohromatskih i termohromatskih premaza na spoljašnjoj površini stakla mogla napraviti ušteda u ukupnoj godišnjoj potrošnji energije od 18,5% u slučaju Atine i 8,1% u slučaju Stokholma.

2. Metamodeliranje i optimizacija potrošnje energije u zgradama:

(**Chegari i dr., 2021.**) su u svom radu predstavili metod za optimizaciju potrošnje energije u zgradama koji je zasnovan na prijemni višeslojnih neuronskih mreža za kreiranje metamodela na koji se primjenjuju tri vrste višekriterijumskih optimizacionih algoritama. Optimizacioni algoritmi koji su korišćeni su NSGA-II, višekriterijumski algoritam roja čestica i višekriterijumski genetski algoritam. Metoda je testirana na primjeru dvospratne kuće u klimatskim uslovima u Marakešu. Od tri korišćena optimizaciona algoritma, najbolji rezultati su se postigli korišćenjem višekriterijumskim algoritmom roja čestica. Rezultati su pokazali da bi optimalno rješenje moglo da napravi uštedu od 74,52% u potrošnji energije koja je potrebna za grijanje i hlađenje prostora, dok bi se osjećaj neugodnosti u kući smanjio za 4,32% u odnosu na bazni model. (**Zhou i dr., 2020.**) su u svom radu predstavili metod optimizacije višeslojne perceptron neuronske mreže za predviđanje potrošnje energije potrebne za grijanje i hlađenje u energetski efikasnim stambenim zgradama. Parametri mreže su optimizovani pomoću algoritama vještačke kolonije pčela i roja čestica. Procjena efikasnosti dobijenih mreža je vršena na osnovu tri parametra i to koeficijenta određenosti, srednje apsolutne greške i korijena srednje kvadratne greške. Pokazalo se da je primjena optimizacionih algoritama dovela do poboljšanja rezultata dobijenih primjenom neuronske mreže u oba slučaja, ali da je optimizacija parametara primjenom algoritma roja čestica dala bolje rezultate u odnosu na algoritam vještačke kolonije pčela. **Wahid i Kim (2016)** su predstavili optimizacioni model koji koristi algoritam vještačke kolonije pčela (ABC) da bi istovremeno smanjio potrošnju energije u zgradi i povećao osjećaj ugodnosti za ljude koji borave u zgradi. Ulazni parametri za ABC algoritam su stvarne vrijednosti temperature, svjetlosti i kvaliteta vazduha u prostoru, kao i željene vrijednosti ovih parametara koje unosi korisnik

prostora. Na osnovu ove dvije vrste unosa parametara, ABC algoritam proračunava optimalne vrijednosti parametara koje se ona šalju u fuzzy kontrolere koji služe za upravljanje procesima u zgradi. Pokazalo se da bi se primjenom ove metode moglo dovesti do smanjenja potrošnje energije kao i istovremenog povećanja osjećaja ugodnosti u prostoru. (Delgarm i dr, 2016) su u svom radu predstavili jednokriterijumske i višekriterijumske optimizacione modele za smanjenje potrošnje energije u zgradama bazirane na algoritmu roja čestica. Optimizacioni modeli su bili napisani kao kod u programskom jeziku MATLAB, a energetska model objekta koji je optimizovan je napravljen u softveru EnergyPlus. Kao objekat za koji je napravljen energetski model je jedna soba, a optimizacija je urađena za četiri klimatske zone u Iranu. Jednokriterijumske optimizacije su kao objektivne funkcije imale smanjenje potrošnje energije potrebne za hlađenje, smanjenje potrošnje energije potrebne za grijanje i smanjenje potrošnje energije potrebne za rasvjetu. Višekriterijumske optimizacije su imale kombinaciju neke od dvije objektivne funkcije kao i kombinaciju sve tri objektivne funkcije. Najveća ukupna ušteda u potrošnji energije je postignuta višekriterijumskom optimizacijom u kojoj su korišćene sve tri objektivne funkcije. Na ovaj način se ukupna potrošnja energije u odnosu na bazni model smanjila za 1,6% - 11,3% u zavisnosti od klimatske zone. U radu (Korolija i dr., 2013), autori su predstavili primjenu regresione analize u cilju predviđanja potrošnje energije u poslovnim zgradama u Ujedinjenom Kraljevstvu. Za treniranje regresionog modela korišćen je set podataka o 3.840 zgrada, a za svaku zgrada je modelirana sa šest različitih vrsta sistema grijanja i klimatizacije, što čini ukupan broj od 23.040 različitih scenarija. Izlazni podaci iz regresionog modela su upoređeni sa stvarnim podacima i na osnovu malih odstupanja se došlo do zaključka da bi se razvijeni regresioni model mogao koristiti za poslovne zgrade u Ujedinjenom Kraljevstvu.

Cilj i hipoteze

Cilj ove doktorske disertacije je razvijanje algoritama i optimizacionih modela koji će služiti za poboljšanje energetske performansi zgrada. Razvijeni algoritmi i modeli će omogućiti optimalan odabir termofizičkih karakteristika zgrada što bi bilo od koristi inženjerima u fazi projektovanja novih i rekonstrukciji postojećih zgrada.

Definisane su sledeće hipoteze:

H1: „Optimalan odabir termofizičkih karakteristika može da doveđe do značajnog poboljšanja energetske performansi zgrada“.

H2: „Primjenom metoda metamodeliranja i metabeurističkih algoritama moguće je razviti efikasne modele za optimalan odabir termofizičkih karakteristika zgrada.“

Materijali, metode i plan istraživanja

Osnovni alati koji će biti korišćeni u ovom istraživanju su softver EnergyPlus, jEPlus i programski jezik MATLAB.

EnergyPlus je softver koji se koristi za dinamičke simulacije potrošnje energije u zgradama i jedan je od vodećih softvera u svijetu u toj oblasti. Softver je korišćen u velikom broju publikovanih istraživanja u oblastima energetske efikasnosti i upotrebe energije u zgradama i smatra se da se rezultati dobijeni ovim softverom mogu koristiti kao benchmark standard. EnergyPlus je softver koji kao ulazne podatke čita, a kao izlazne podatke ispisuje tekst fajlove. Softver omogućava analizu potrošnje energije koja je potrebna za grijanje i klimatizaciju prostora, rasvjetu, pokretanje električnih uređaja i procesnu tehniku koja se koristi u zgradama. Simulacije u EnergyPlus-u su dinamičke i simuliraju potrošnju energije i rad različitih sistema u zgradama u periodu od godinu dana. Simulacije mogu imati vremenski korak od sat vremena pa sve do jednog minuta u zavisnosti od potreba analize i korišćenog algoritma proračuna. Pored potrošnje energije u zgradama, EnergyPlus se može koristiti i za simulaciju proizvodnje energije iz vjetroturbin i solarnih panela.

jEPlus je softver koji se koristi za parametarske analize i ispitivanja energetske performansi zgrada koji su kreirani u softverima EnergyPlus ili TRNSYS. U ovom istraživanju softver jEPlus će biti

korišćen kao veza između osnovnih energetskih modela zgrade koji su kreirani u EnergyPlus-u i kodova koji su napisani u programskom jeziku MATLAB. Ovo se može postići zahvaljujući mogućnosti jEplus-a da direktno pokrene simulacije u EnergyPlus-u i mogućnosti da se jEplus-om upravlja preko command prompta, što se može učiniti direktno iz MATLAB-a.

Programski jezik MATLAB će se koristiti za pisanje programa koji će koristiti simulacije napravljene u EnergyPlus-u za kreiranje metamodela, kao i za pravljenje optimizacionih modela. Prvi korak u istraživanju biće ispitivanje uticaja različitih parametara i termofizičkih karakteristika zgrada na energetske performanse, za zgrade u različitim klimatskim zonama. Ispitivaće se kakav uticaj ti parametri imaju na potrošnju energije u zgradama kao i uticaj tih parametara na poklapanje krivih potrošnje energije i proizvodnje energije iz obnovljivih izvora. Na ovaj način će se utvrditi koji parametri zgrada bi trebali da budu optimizovani da bi se poboljšale energetske performanse. U literaturi se može naći veliki broj istraživanja o uticaju termofizičkih karakteristika zgrada na ukupnu potrošnju energije, ali je uticaj tih karakteristika na poklapanje, odnosno odstupanje krivih potrošnje energije i proizvodnje energije iz obnovljivih izvora slabo ispitan. Takođe još jedan faktor koji je slabo ispitan jeste uticaj termofizičkih karakteristika omotača zgrade na pojedinačnim stranama svijeta. Različite strane svijeta primaju različite količine sunčevog zračenja i zbog različitih napadnih uglova vjetrova imaju i različite koeficijente prelaska toplote i stope infiltracije vazduha na otvorima. Zbog ovoga je moguće da bi optimalne termofizičke karakteristike omotača zgrade na različitim stranama svijeta mogle takođe da budu različite pa je i ovo jedan od faktora koji će biti ispitan u prvom dijelu istraživanja.

Drugi korak u istraživanju će biti razvijanje algoritma za što efikasnije metamodeliranje potrošnje energije u zgradama. U literaturi se mogu naći primjeri korišćenja metamodela za procjenu potrošnje energije u zgradama, ali u ovim istraživanjima se predlaže po jedna metoda npr. regresija Gausovim procesima, algoritmi sa višeslojnim neuronskim mrežama itd., za sve slučajeve modeliranja, nezavisno od toga koje promjenjive čine ulazne podatke za model i šta je rezultat modela. Nedostatak ovog pristupa leži u činjenici da brzina konvergencije treniranja modela, uz primjenu jednog istog algoritma, neće biti ista u ukoliko bi se promijenio broj promjenjivih, vrsta promjenjivih, vrsta rezultata ili sama veza između ulaznih promjenjivih i rezultata. Ukoliko bi se ista zgrada simulirala u drugačijim klimatskim uslovima ili bi bili promijenjeni operativno vrijeme zgrade, geometrija zgrade, sistem klimatizacije itd. promijenio bi se i uticaj ulaznih podataka na rezultat modela, što bi moglo da dovede do situacije da ukoliko je neki algoritam imao brzu konvergenciju u jednom primjeru, u drugom primjeru bi konvergencija sa istim algoritmom mogla da bude spora. Iz ovog razloga je planirano da se razvije algoritam koji će koristiti prednosti modernih višejezgarskih procesora i paralelnog programiranja. Razvijeni algoritam će paralelno koristiti više metoda za metamodeliranje (modeli linearne i polinomalne regresije, modeli potpornih vektora, modeli Gausovih procesa, modeli neuronskih mreža i modeli regresionih stabala). Pošto je nemoguće unaprijed znati koliki broj rezultata i kombinacija ulaznih promjenjivih je potrebno za postizanje konvergencije, pri korišćenju bilo koje od metoda metamodeliranja, algoritam će pozivati novu simulaciju u EnergyPlus-u koja će se iskoristiti za treniranje modela sve dok uslov konvergencije ne bude bio ispunjen. Uslov konvergencije koji će algoritam koristiti je unaprijed određena maksimalno dozvoljena greška metamodela. Algoritam će odabrati metamodel koji je prvi konvergirao i proces dalje simulacije će se zaustaviti. Na ovaj način će se omogućiti najbrža konvergencija treniranja modela nezavisno od toga koji se ulazni parametri koriste i koji parametar predstavlja rezultate modela. Ovakav pristup metamodeliranju bi bio efikasan i u slučajevima kada se za izradu metamodela ne bi koristile ulazne promjenjive koje će se utvrditi u prvom dijelu istraživanja.

Treći korak u istraživanju će biti razvijanje optimizacionih modela koji će kao objektivne funkcije koristiti metamodela razvijene u drugom dijelu istraživanja, a kao promjenjive će koristiti parametre za koje je u prvom dijelu istraživanja utvrđeno da bi se trebali optimizovati. Za razvoj optimizacionih modela će se koristiti metaheuristički algoritmi. Prvi korak u razvoju

optimizacionih modela će biti razvijanje modela koji će kao jedini cilj imati minimalizaciju ukupne potrošnje energije u zgradama, a potom će biti razvijeni modeli koji će kao jedini cilj imati minimalizaciju odstupanja krivih potrošnje energije u zgradama od krive proizvodnje energije iz obnovljivih izvora. Nakon ovoga će se razviti i višekriterijumski modeli koji će davati nedominantna rješenja pri istovremenoj minimalizaciji ukupne potrošnje energije i minimalizaciji odstupanja krivih potrošnje energije od krive proizvodnje energije iz obnovljivih izvora. Posljednji dio istraživanja će odnositi na izradu studija slučaja, za više tipova zgrada i u više klimatskih zona, primjenom razvijenih algoritama i optimizacionih modela. Na ovaj način će se moći izvući neki opšti zaključci i preporuke oko odabira termofizičkih karakteristika za različite tipove zgrada u različitim klimatskim zonama u slučajevima kada inženjeri koji rade na projektovanju zgrada ne bi vršili detaljne analize i optimizacije za tačno određenu zgradu koju projektuju.

Očekivani naučni doprinos

Očekivani naučni doprinos:

1. Utvrđivanje parametara i termofizičkih karakteristika omotača zgrada koje bi u fazi projektovanja trebalo optimizovati da bi se poboljšale energetske performanse zgrada.
2. Razvoj efikasnog algoritma za metamodeliranje energetskog odziva zgrada.
3. Razvoj optimizacionih modela koji koriste metamodel kao objektivnu funkciju za minimalizaciju potrošnje energije u zgradama.
4. Razvoj optimizacionih modela koji koriste metamodel kao objektivnu funkciju za minimalizaciju odstupanja krive potrošnje energije u zgradama u odnosu na krivu proizvodnje energije iz obnovljivih izvora.
5. Razvoj višekriterijumskih optimizacionih modela koji daju nedominantna rješenja pri istovremenoj minimalizaciji potrošnje energije u zgradama i minimalizaciji odstupanja krive potrošnje energije u odnosu na krivu proizvodnje energije iz obnovljivih izvora.
6. Izrada studija slučaja, za više tipova zgrada u više klimatskih zona, primjenom razvijenih algoritama i modela na osnovu kojih će se moći dati opšte preporuke.

Spisak objavljenih radova kandidata
Radovi na SCI/SCIE listi:

- [1] **B. Hrnčić**, A. Pfeifer, F. Jurić, N. Duić, V. Ivanović, I. Vušanović. Different investment dynamics in energy transition towards a 100% renewable energy system. *Energy*. 2021; 237 - 121526 <https://doi.org/10.1016/j.energy.2021.121526>

Radovi na konferencijama:

- [2] **B. Hrnčić**, A. Pfeifer, V. Ivanović, I. Vušanović, Energy Transition Towards Achieving a 100% Renewable Energy System: Case Study of Montenegro, 4th SEESDEWES, Sarajevo, Bosnia and Herzegovina, Jun 28th – July 02nd, 2020.

Popis literature


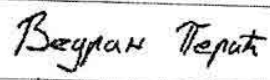
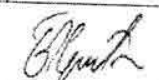
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SAGLASNOST PREDLOŽENOG/IH MENTORA I DOKTORANDA SA PRIJAVOM

Odgovorno potvrđujem da sam saglasan sa temom koja se prijavljuje.

Prvi mentor	Igor Vušanović	
Drugi mentor	Vedran Perić	
Doktorand	Boris Hrnčić	

IZJAVA



UCG


UNIVERZITET CRNE GORE
Obrazac PD: Prijava teme doktorske disertacije


Odgovorno izjavljujem da doktorsku disertaciju sa istom temom nisam prijavio/la ni na jednom drugom fakultetu.


U Podgorici,
08.10.2021.

Boris Hrnčić

LIČNE INFORMACIJE**Boris Hrnčić**

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Pol muški | Datum rođenja 08/07/1996. | Državljanstvo Crna Gora

RADNO ISKUSTVO

Novembar 2019. -
danas

Saradnik u nastavi

Univerzitet Crne Gore

Mašinski fakultet

Podgorica, Crna Gora

- Saradnik u nastavi na predmetima iz oblasti termotehnike i termoenergetike
- Naučno-istraživački rad

Januar 2019. –
Oktobar 2019.

Prirpavnik - Stručno osposobljavanje lica sa stečenim visokim obrazovanjem

Univerzitet Crne Gore

Mašinski fakultet

Podgorica, Crna Gora

- Rad na pripremi laboratorijskih vježbi i ispitivanja

**OBRAZOVANJE I
OSPOSBLJAVANJE**

2020. - danas

Doktorske studije

Univerzitet Crne Gore, Mašinski fakultet

2019. – 2020.

Magistar mašinstva

Univerzitet Crne Gore, Mašinski fakultet

- Smjer: Energetika
- Struktura: 4 ispita + magistarski rad
- Naziv teme: „Analiza mogućnosti postizanja sto posto obnovljivog energetskog sistema u Crnoj Gori“

2018. – 2019.

Specijalista mašinstva

Univerzitet Crne Gore, Mašinski fakultet

- Smjer: Energetika
- Struktura: 12 ispita + specijalistički rad
- Naziv teme: „Idejni projekat zamjene mazuta u kotlarnici Kliničkog centra Crne Gore“

2015. – 2018.

Bechelor mašinstva

Univerzitet Crne Gore, Mašinski fakultet

- Smjer: Energetika
- Struktura: 38 ispita

LIČNE VJEŠTINE I KOMPETENCIJE

Maternji jezik srpski / crnogorski

Ostali jezici

Engleski jezik

RAZUMIJEVANJE		GOVOR		PISANJE
Slušanje	Čitanje	Govorna interakcija	Govorna produkcija	
C2	C2	C2	C2	C2

Komunikacione vještine

Dobre komunikacijske vještine stečene kroz nastavno iskustvo i timski rad na brojnim stručnim projektima

Digitalna kompetencija

SAMOPROCJENA				
Obrada informacija	Komunikacija	Stvaranje sadržaja	Sigurnost	Rješavanje problema
Kompetentna upotreba	Kompetentna upotreba	Kompetentna upotreba	Kompetentna upotreba	Kompetentna upotreba

Ostale digitalne kompetencije

Poznavanje rada na velikom broju programa i programskih paketa:

- Microsoft office, Matlab, AutoCAD, AutoCAD MEP, Revit, MagiCAD, Inventor, EnergyPLAN, EnergyPlus, HanibalSoft, IntegraCAD.

Vozačka dozvola B kategorija.

BIBLIOGRAFIJA

SCI/SCIE

B. Hrnčić, A. Pfeifer, F. Jurić, N. Duić, V. Ivanović, I. Vušanović. Different investment dynamics in energy transition towards a 100% renewable energy system. *Energy*. 2021; 237 - 121526
<https://doi.org/10.1016/j.energy.2021.121526>

Konferencije

B. Hrnčić, A. Pfeifer, V. Ivanović, I. Vušanović, Energy Transition Towards Achieving a 100% Renewable Energy System: Case Study of Montenegro. 4th SEESDEWES, Sarajevo, Bosnia and Herzegovina, Jun 28th – July 02nd, 2020

DODATNE INFORMACIJE

Projekti

Saradnik na izradi velikog broja stručnih projekata iz oblasti termotehničkih, protivpožarnih, gasnih i solarnih instalacija

Na osnovu člana 33 Zakona o upravnom postupku ("Službeni list CG", br. 56/14, 20/15, 40/16 i 37/17), člana 115 Zakona o visokom obrazovanju ("Službeni list CG", br. 44/14, 52/14, 47/15, 40/16, 42/17, 71/17, 55/18, 3/19, 17/19, 47/19, 72/19, 74/20 104/21) i službene evidencije, a po zahtjevu studenta Hrnčić Goran Boris, izdaje se

UVJERENJE O POLOŽENIM ISPITIMA

Student **Hrnčić Goran Boris**, rođen **08-07-1996** godine u mjestu **Podgorica**, opština **Podgorica**, Republika Crna Gora, upisan je studijske **2020/2021** godine, u **I** godinu studija, kao student koji se **samofinansira na doktorske akademske studije**, studijski program **MAŠINSTVO**, koji realizuje **MAŠINSKI FAKULTET - Podgorica** Univerziteta Crne Gore u trajanju od **3 (tri)** godine sa obimom **180** ECTS kredita.

Student je položio ispite iz sljedećih predmeta:

Redni broj	Semestar	Naziv predmeta	Ocjena	Uspjeh	Broj ECTS kredita
1.	1	AKVIZICIJA I OBRADA EKSPERIMENTALNIH PODATAKA	"A"	(odličan)	8.00
2.	1	CVFEM NUMERIČKE METODE ZA FLUIDE I ČVRSTA TIJELA	"A"	(odličan)	8.00
3.	1	METODE NAUČNO-ISTRAŽIVAČKOG RADA	"A"	(odličan)	6.00
4.	2	ENERGETSKA I EKSERGETSKA ANALIZA	"A"	(odličan)	8.00
5.	2	ODABRANA POGLAVLJA IZ KLIMATIZACIJE	"B"	(vrlodobar)	8.00

Zaključno sa rednim brojem **5**.

Ostvareni uspjeh u toku dosadašnjih studija je:

- srednja ocjena položenih ispita "A" (9.79)
- ukupan broj osvojenih ECTS kredita **38.00** ili **63.33%**
- indeks uspjeha **6.20**.

Uvjerjenje se izdaje na osnovu službene evidencije, a u svrhu ostvarivanja prava na: (dječji dodatak, porodičnu penziju, invalidski dodatak, zdravstvenu legitimaciju, povlašćenu vožnju za gradski saobraćaj, studentski dom, studentski kredit, stipendiju, regulisanje vojne obaveze i slično).

Broj: **2866**
Podgorica, 08.10.2021 godine



SEKRETAR





UNIVERZITET CRNE GORE MAŠINSKI FAKULTET PODGORICA



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MAŠINSKI FAKULTET KOMISIJA ZA DOKTORSKE STUDIJE

PREDMET: Predlog komisije za odbranu polaznih istraživanja za izradu doktorske disertacije

Odlukom Senata Univerziteta Crne Gore br. 03-368/1-1 od 10.03.2021. godine imenovan sam za mentora na izradi doktorske disertacije kandidatu mr Borisu Hrnčiću.

Pošto su se stekli uslovi za odbranu polaznih istraživanja, i na osnovu razgovora sa kandidatom **mr Borisom Hrnčićem**, predlažem **Komisiju za odbranu polaznih istraživanja** za izradu doktorske disertacije pod nazivom:

„Metamodeliranje energetskeg odziva zgrada i višekriterijumska optimizacija sa aspekta poboljšanja energetske performansi“

u sledećem sastavu:

1. Prof. dr Vladan Ivanović, predsjednik,
2. Prof. dr Igor Vušanović, mentor,
3. Dr Vedran Perić, komentor,
4. Doc. dr Milan Šekularac, član,
5. Doc. dr Esad Tombarević, član.

UNIVERZITET CRNE GORE MAŠINSKI FAKULTET			
Pr. broj	Org. jed.	Broj	Vrijedn.
		2571	

U Podgorici, 11.10.2021

UNIVERZITET CRNE GORE
MAŠINSKI FAKULTET
MENTOR
Igor Vušanović
Prof. dr Igor Vušanović

Na osnovu člana 32 stav 1 tačka 14 Statuta Univerziteta Crne Gore, u vezi sa članom 29 Pravila doktorskih studija, Senat Univerziteta Crne Gore, u postupku razmatranja prijedloga Vijeća Mašinskog fakulteta i na prijedlog Centra za doktorske studije, na sjednici održanoj 10.03.2021. godine, donio je sljedeću

ODLUKU

I

Dr Igor Vušanović, redovni profesor Mašinskog fakulteta Univerziteta Crne Gore imenuje se za mentora pri izradi doktorske disertacije kandidata mr Borisa Hrnčića.

II

Dr Vedran Perić, Head of research Center imenuje se za komentora, pri izradi doktorske disertacije kandidata mr Borisa Hrnčića.

III

Odluka stupa na snagu danom donošenja.

Broj: 03- 368/1-1

Podgorica, 10.03.2021. godine

Crna Gora UNIVERZITET CRNE GORE MAŠINSKI FAKULTET			
Predmet: 17.03.21			
Org. jed.	Broj	Pol.	Vrijednost
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PREDSJEDNIK SENATA

Prof. dr. Vladimir Božović, vršilac funkcije rektora

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Na osnovu člana 75 stav 2 Zakona o visokom obrazovanju (Sl.list RCG, br. 60/03 i Sl.list CG, br. 45/10) i člana 18 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 28.10.2010. godine, donio je

ODLUKU O IZBORU U ZVANJE

Dr **VLADAN IVANOVIĆ** bira se u akademsko zvanje **redovni profesor** Univerziteta Crne Gore za predmete: Kotlovi, Projekovanje energetskih postrojenja, Zaštita životne sredine i Termoelektrane na **Mašinskom fakultetu** i Parna tehnika na Fakultetu za pomorstvo.

REKTOR

Prof. dr Predrag Miranović



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Na osnovu člana 75 stav 2 Zakona o visokom obrazovanju (Sl.list RCG, br. 60/03 i Sl.list CG, br. 45/10 i 47/11) i člana 18 stav 1 tačka 3 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 27.06.2013. godine, donio je

**ODLUKU
O IZBORU U ZVANJE**

Dr IGOR VUŠANOVIĆ bira se u akademsko zvanje **redovni profesor** Univerziteta Crne Gore za predmete: Termodinamika, Energetika u saobraćaju, Kompjuterske metode u energetici i Mjerenje i simulacija energetskih procesa, na Mašinskom fakultetu.



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Datum / Date 25. 12. 2018

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ODLUKU O IZBORU U ZVANJE

Dr MILAN ŠEKULARAC bira se u akademsko zvanje **docent Univerziteta Crne Gore za oblast Termotehnika na Mašinskom fakultetu Univerziteta Crne Gore**, na period od pet godina.



**SENAT UNIVERZITETA CRNE GORE
PREDSJEDNIK**

Prof.dr Danilo Nikolić, rektor

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Priloga	09. 01. 2019		
Org. jed	Str.	Polj.	Vodovod
	02		



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Broj / Ref 03 - 547

Datum / Date 12. 02. 2019

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju („Službeni list Crne Gore“ br. 44/14, 47/15, 40/16, 42/17, 71/17 i 55/18) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 12.02. 2019.godine, donio je

O D L U K U O IZBORU U ZVANJE

Dr ESAD TOMBAREVIĆ bira se u akademsko zvanje **docent Univerziteta Crne Gore za oblast Termotehnika (Energija i životna okolina – osnovne studije, studijski program Mašinstvo; Osnove tehnike hlađenja – osnovne studije, studijski program Mašinstvo; Klimatizacija – master studije, studijski program Mašinstvo; Energetska efikasnost u zgradarstvu – master studije, studijski program Energetska efikasnost) na Mašinskom fakultetu Univerziteta Crne Gore, na period od pet godina.**



**SENAT UNIVERZITETA CRNE GORE
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MAŠINSKI FAKULTET

Priloga	<u>18.2.2019</u>		
Broj	224	Prilog	Vrijednost

BIOGRAFIJA

Ime i prezime: Vladan Ivanović

Lični podaci i podaci o obrazovanju

Rođen sam u Beogradu 05.12.1956. godine. Osnovnu školu i gimnaziju, prirodno - matematičkog smjera završio sam u Prištini.

Na Tehnički fakultet - Mašinski odsek, termoeenergetski smer Univerziteta u Prištini, upisao sam se školske 1975/76. godine. Na istom sam diplomirao oktobra 1980. godine.

Poslediplomske studije završio sam na Mašinskom fakultetu Univerziteta u Beogradu na kome sam 26.06.1995. godine odbranio magistarsku tezu pod nazivom "Izbor metode termičkog proračuna za ložišta parnih kotlova na kosovski lignit".

Na Mašinskom fakultetu Univerziteta u Prištini 19.06.1998. godine odbranio sam doktorsku disertaciju pod nazivom "Prilog proučavanju razmene toplote u ložištim parnih kotlova pri sagorevanju kosovskog lignita primenom modifikovanog zonalnog proračuna".

Državni stručni ispit za diplomiranog inženjera mašinstva položio sam 02.11.1983. godine. Uverenje br. 06-152-1-255/83-1003 od 22.12.1983. godine.

Završio sam kurs za programera AOP 17.07.1989. godine. Uverenje br. 886/40 od 29.08.1989. godine.

Posedujem Ovlašćenje za projektovanje Inženjerske komore Crne Gore, čiji sam član počevši od njenog osnivanja, r.br. MP 17213 0018 od 20.02.2003. godine.

Podaci o radnim mjestima i izborima u zvanja

Stalni radni odnos u MPRO „Montaža“ OOUR „Klimatizacija“ iz Beograda zasnovao sam 15.12.1980. godine, prvo na radnom mjestu diplomiranog mašinskog inženjera pripravnika, a po položenom pripravnikom ispitu na radnom mjestu šefa gradilišta, počevši od III grupe pa do I grupe. Od 14.01.1985. godine raspoređen sam na radno mjesto rukovodioca sektora.

21.03.1985. godine izabran sam za asistenta pripravnika na Katedri za termo i hidrotehniku Tehničkog fakulteta OOUR Mašinstvo Univerziteta u Prištini. U početku sam poslove **asistenta pripravnika** obavljao kao spoljnji saradnik da bi od 02.10.1986 godine prešao u stalni radni odnos.

U periodu od 01.10.1990. do 26.03.1991. godine radio sam na radnom mjestu rukovodioca RJ Centralno grejanje u DP "Zmaj" iz Smedereva.

U zvanje **saradnika asistenta** za predmete Katedre za termoeeneretiku i termotehniku izabran sam 17.01.1996. godine.

U toku rada na fakultetu bio sam angažovan na održavanju vježbi iz predmeta Katedre za termo i hidro tehniku, kasnije Katedre za termoeenergetiku i termotehniku: Tehničko crtanje, Hidrauličke turbomašine, Toplotne turbomašine, Termoeenergetska postrojenja, Termodinamika, Mehanika fluida, Motori SUS, Merenje u energetici, Grejanje i klimatizacija i Parni kotlovi.

Za održavanje vježbi iz predmeta Grejanje i klimatizacija u periodu 1993 – 1996. godina bio sam angažovan i na Građevinsko - arhitektonskom fakultetu u Prištini a 1998/99 izvodim nastavu iz predmeta Mašinske instalacije.

U zvanje **docenta** za predmet Parni kotlovi na Mašinskom fakultetu Univerziteta u Prištini izabran sam 17.11.1998. godine gde sam održavao vježbe i predavanja iz tog predmeta.

Na Mašinskom fakultetu u Podgorici sam školske 1999/2000. godine angažovan za održavanje vježbi iz predmeta Kotlovi.

U zvanje **docenta** za predmete Parni kotlovi i Energetska postrojenja – termoenergetski dio na Mašinskom fakultetu Univerziteta u Podgorici izabran sam 31.05.2000. godine.

Na Građevinskom fakultetu Univerziteta u Podgorici održavam i nastavu iz predmeta Komunalna infrastruktura – dio toplifikacije počev od školske 1999/2000. godine.

Na Fakultetu tehničkih nauka u Kosovskoj Mitrovici sam izvodio nastavu iz predmeta Parni kotlovi na Mašinskom odseku od školske 1999/2000 do 2002/2003, a na Elektro odseku istog fakulteta održavanje nastave iz predmeta Hidro i termo postrojenja od školske 2002/2003 do 2005/206.

U zvanje **vanrednog profesora** Univerziteta Crne Gore za predmete: Kotlovi, Projektovanje energetskih postrojenja, Zaštita životne sredine i Termoelektrane na Mašinskom fakultetu i Komunalna infrastruktura na Građevinskom fakultetu u Podgorici izabran sam 14.09.2005. godine.

U zvanje **redovnog profesora** Univerziteta Crne Gore za predmete: Kotlovi, Projektovanje energetskih postrojenja, Zaštita životne sredine i Termoelektrane na Mašinskom fakultetu i Parna tehnika na Fakultetu za pomorstvo u Kotoru izabran sam 28.10.2010. godine.

Pored nastave na predmetima za koje sam izabran izvodim i nastavu na Specijalističkim studijama iz predmeta Grijanje i provetravanje, Projektovanje termotehničkih instalacija i Sagorijevanje na fakultetu u Podgorici kao i Energetika u preradi drveta u odeljenju u Pljevljima. Na Doktorskim studijama nastavu iz predmeta Izabrana poglavlja iz kotlova, Izabrana poglavlja iz turbina, a na Magistarskim studijama Toplotne turbomašine i Zaštita vode i vazduha. Na Fakultetu za pomorstvo u Kotoru nastavu iz predmeta Brodski parni kotlovi, Brodske parne i gasne turbine i Parna tehnika počevši od školske 2006/2007. godine izvodim i sada.

Na Arhitektonskom fakultetu u Podgorici na osnovnim studijama izvodim nastavu iz predmeta Instalacije u zgradama, mašinski dio, a na Građevinskom fakultetu - Građevinska fizika i instalacije, mašinski dio, na osnovnim studijama počevši od školske 2009/2010. godine i na Magistarskim studijama ENERESE predmete Uticaj potrošnje energije na životnu sredinu i Geotermalna energija i energija biomase.

Rukovodilac sam studijskog programa Enegetska efikasnost.

A. Magistarski i doktorski rad

1. Ivanović V.
IZBOR METODE TERMIČKOG PRORAČUNA ZA LOŽIŠTA PARNIH KOTLOVA NA KOSOVSKI LIGNIT, Magistarski rad, Mašinski fakultet, Beograd, jun 1995.
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PRILOG PROUČAVANJU RAZMENE TOPLOTE U LOŽIŠTIMA PARNIH KOTLOVA PRI SAGOREVANJU KOSOVSKOG LIGNITA PRIMENOM MODIFIKOVANOG ZONALNOG PRORAČUNA, Doktorski rad, Mašinski fakultet, Priština, jun 1998.

Skripte

1. Ivanović V.: Komunalna infrastruktura - toplifikacija i gasifikacija, skripta, Podgorica, Građevinski fakultet, 2001, COBISS CG-ID 512168677
2. Ivanović V.: Brodske parne i gasne turbine, skripta, Kotor, Fakultet za pomorstvo, 2007, COBISS CG-ID 512171490
3. Ivanović V.: Brodski parni kotlovi, skripta, Kotor, Fakultet za pomorstvo, 2007, COBISS CG-ID 512171746

Naučno - stručni radovi

1. Ivanović V.: IZBOR METODE TERMIČKOG PRORAČUNA ZA LOŽIŠTA PARNIH KOTLOVA NA KOSOVSKI LIGNIT, Sastanak specijalističkih radnih grupa u TE "Morava", Svilajnac, jun 1995.
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3. Ivanović V., Bajmak Š., Aković R.: PRORAČUN KOMBINOVANOG SAGOREVANJA TVRDOG KOMUNALNOG OTPADA I FOSILNOG GORIVA, Industrijska energetika 96, Herceg Novi, oktobar 1996, str 505-509.
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5. Kontić Z., Ivanović V.: UŠTEDA LAKOG TEČNOG GORIVA U TE "KOSOVO A", Elektroprivreda, br. 3/ 1996, str 48-55.
6. Bajmak Š., Aković R., Ivanović V.: ODREĐIVANJE OPTIMALNE DEBLJINE IZOLACIJE CEVOVODA HLADNE VODE I ANALIZA RASTA TEMPERATURA HLADNE VODE DUŽ CEVOVODA, JU-TERM 97, jun 1997, str 192-193.
7. Bajmak Š., Ivanović V., Aković R.: ODREĐIVANJE OPTIMALNIH PARAMETARA MAGISTRALNIH VAZDUŠNIH KANALA U SISTEMIMA KLIMATIZACIJE I VENTILACIJE, JU-TERM 97, jun 1997, str 194-195.
8. Ivanović V., Bajmak Š., Aković R.: OPTIMALNE GRANULOMETRIJSKE KARAKTERISTIKE GORIVA PRI SAGOREVANJU U LOŽIŠTU PARNOG KOTLA OP-650b U TE "KOSOVO" , Procesna tehnika br. 3 - 4/97, str 201-203.
9. Ivanović V., Brkić Lj.: DETERMINE OF MILLING FINENESS BASED ON CALCULATIONS OF COAL DUST COMBASTION, International simposium "Utilisation of coal for energy", Ohrid, october 1997, Proceeding - book 1, pp 412-416.
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11. Ivanović V., Bajmak Š.: ANALIZA OPREDELENIA RASHODA TOPLIVA NA VÍRABOTKU ÉLEKTRIAESKOÍ ÉNERGII I TEPLITI NA GAZOTURBINNÍH TEC, Energie forum 98, Varna
12. Bajmak Š., Ivanović V.: OPREDELENIE OPTIMALÉNEÍ RAZNOSTI TEMPERATUR HLADONOSITELÁ V SISTEMÍ CENTRALIZOVANOGO HLADOSNABÆENIA, Energie forum 98, Varna
13. Ivanović V., Bajmak Š., Aković R.: TERMIČKE OSOBINE LOŽIŠTA PARNIH KOTLOVA U TE "KOSOVO", II savjetovanje Energetika Srpske 98, Banja Vrućica - Teslić, oktobar 1998
14. Ivanović V., Brkić Lj.: ESTIMATE OF MILLING FINENESS BASED ON CALCULATIONS OF COAL DUST COMBASTION, Thermal Science: Vol. 3 (1999), No3, pp. 87-92.
15. Ivanović V.: THE ONE-DIMENSIONAL ZONAL METHOD OF THE FURNACE THERMAL CALCULATION, 6th European conference on industrial furnaces and boilers, INFUB, Estoril-Lisbon-Portugal, April 2002, Proceedings, Vol III, Modelling of furnaces and combustion systems, pp 281-290. ISBN 972-8034-05-9

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17. Ivanović V.: EKOLOŠKE TERMoeLEKTRANE, Alternativni izvori energije i budućnost njihove primene u zemlji, CANU, Odjeljenje prirodnih nauka, knjiga 7, Podgorica 2002, str 131-136. ISBN 86-7215-123-2
18. Ivanović V.: SMANJENJE NEGATIVNOG UTICAJA NA OKOLINU PRI SAGOREVANJU UGLJENOG PRAHA, Procesna tehnika br. 1/2003, str 135-137. UDK 662.933.581.52. BIBLID 0352-678X(2003) 19:1 p 135-137
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23. Vukašinić S., Ivanović V., Gačević D., Ivanović D.: TEHNO - EKONOMSKA OPRAVDANOST IZGRADNJE BLOKA II TE "PLJEVLJA", Simpozijum ELEKTRANE 2004 sa međunarodnim učešćem, DTSCG, Vrnjačka Banja, Novembar 2004.
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28. Ivanović V.: REZULTATI TERMIČKOG PRORAČUNA LOŽIŠTA PARNOG KOTLA SI-1000, Monografija povodom 35 godina studija mašinstva u Crnoj Gori, Mašinski fakultet, Podgorica 2005.
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3. Ivanović V. - projektant
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4. Ivanović V. - odgovorni projektant
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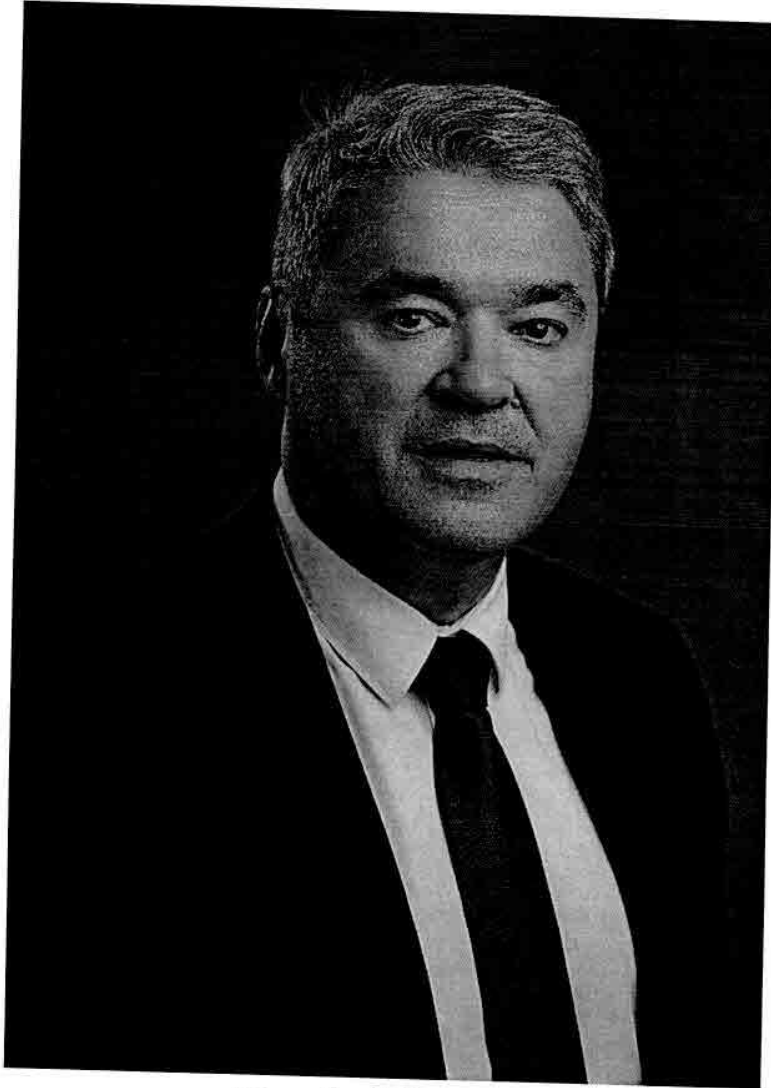
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Glavni mašinski projekat instalacije centralnog grejanja nadgradNje potkrovlja u
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- POSLOVNOG OBJEKTA "UNISTAN" U PODGORICI, Građevinski fakultet – Institut za građevinarstvo, Podgorica, April 2005.
23. Ivanović V. - odgovorni projektant
GLAVNI PROJEKAT VENTILACIJE ARHITEKTONSKOG FAKULTETA U PODGORICI, Građevinski fakultet – Institut za građevinarstvo, Podgorica, Juli 2005.
 24. Ivanović V. - odgovorni projektant
Glavni projekat TERMOTEHNIČKIH INSTALACIJA DOMA ZDRAVLJA "POBREŽJE" U PODGORICI, iNG-INVEST, Danilovgrad, Avgust 2005.
 25. Ivanović V. - odgovorni projektant
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 29. Ivanović V. - odgovorni projektant
Glavni projekat TERMOTEHNIČKIH INSTALACIJA JAVNE USTANOVE ZA REHABILITACIJU KORISNIKA PSIHOAKTIVNIH SUPSTANCI U PODGORICI, iNG-INVEST, Danilovgrad, Septembar 2005.
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Glavni projekat TERMOTEHNIČKIH INSTALACIJA OBJEKTA ZA OSUDJENE ŽENE I MALOLJETNIKE U SPUŽU, iNG-INVEST, Danilovgrad, Decembar 2006.
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 37. Ivanović V. - odgovorni projektant
DOPUNA GLAVNOG PROJEKAT TERMOTEHNIČKIH INSTALACIJA

- POSLOVNOG PROSTORA U KULI 9C OBJEKTA "UNISTAN" U PODGORICI,
Građevinski fakultet – Institut za građevinarstvo, Podgorica, Jun 2009.
38. Ivanović V. - odgovorni projektant
PROJEKAT INVESTICIONOG ODRŽAVANJA TERMOTEHNIČKIH INSTALACIJA
"POSLOVNA ZGRADA AGENCIJE EKIP", Institut za građevinarstvo, Podgorica,
Septembar 2015.
39. Ivanović V. - odgovorni projektant
PROJEKAT INVESTICIONOG ODRŽAVANJA TERMOTEHNIČKIH INSTALACIJA
GKMC "DAJBABSKA GORA", Institut za građevinarstvo, Podgorica, Septembar 2015.
40. Ivanović V. - odgovorni projektant
GLAVNI MAŠINSKI PROJEKAT ADAPTACIJE ENTERIJERA CENTRALNE
UNIVERZITETSKE BIBLIOTEKE SA ČITAONICOM I KANCELARIJSKIM
PROSTORIMA – TERMOTEHNIČKE INSTALACIJE
Podgorica, Septembar 2018.
41. Ivanović V. - odgovorni projektant
GLAVNI PROJEKAT MAŠINSKIH INSTALACIJA GRIJANJA, VENTILACIJE I
KLIMATIZACIJE AMFITEATRA 106 U ZGRADI TEHNIČKIH FAKULTETA
Podgorica, Maj 2020

CURRICULUM VITAE

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Education

2002 Ph.D. Degree, Mechanical Engineering, University of Montenegro;
1996 M.S. Degree, Mechanical Engineering, University of Montenegro;
1992 B.S. Mechanical Engineering Degree, University of Belgrade;

Employment

2016 -

Dean of Mechanical Engineering, University of Montenegro

2012 -

Full Professor, University of Montenegro, Faculty of Mechanical Engineering;

2008 - 2012

Associate Professor, University of Montenegro, Faculty of Mechanical Engineering;

2003-2008

Assistant Professor, University of Montenegro, Faculty of Mechanical Engineering;

1996-2002

Assistant (Second Level), University of Montenegro, Faculty of Mechanical Engineering;

1992-1996

Assistant (First Level), University of Montenegro, Faculty of Mechanical Engineering

Honors

Purdue University, School of Materials Engineering, USA, Visiting Scholar, Fellowship of Ministry of Science of Montenegro, 1999

Ministry of Science and Education Scholarship, 1989/90, 1990/91, and 1991/92, (granted to students with high scholastic record)

Grants

University of Belgrade, Best student of generation 1992

Professional Societies

ASHRAE, Associate Member, USA

Research Interests

The main thrust of my research was the mathematical and numerical modeling of different transport phenomena processes. One of the purest examples is solidification of multi-component alloys. Concentration equation is additionally accompanied to the standard set of equations (flow and energy equation) and therefore additional thermodynamic modeling is necessary to get closed set ready to be solved. This additional model is known in literature as microsegregation model and in multicomponent system is usually based on two different sets of equations: generic conservation equations of enthalpy and concentration and comprehensive phase diagram that describes relation between phases that precipitates during the freezing process.

Next research interest is developing of different numerical techniques for solving standard set of transport equations. Recently we developed solution based on CVFEM numerical scheme (Control Volume Finite Element Method) which was applied in case of geothermal modeling of "U" type heat exchangers. Heat pumps as a devices is one of the key global solutions to the path of decarbonization in household and building stock in every city. We are interested to explore possibilities to use the soil as a heat sink and source for

heat pump systems, on sustainable way to preserve existing plants and keeping soil energy balances in both summer and winter season.

Another field that we are interested in our group is dynamic modeling of heat and cooling demands for building stock and household, in order to construct and design so called zero energy buildings (ZEB). Numerical techniques for this comprehensive modeling is based on solving of basic heat transfer equations of heat transfer, using periodic behavior of heat load in buildings and unsteady cooling, and solving of phenomena of heat island in cities.

Next field of interest is energy planning toward the implementation of RES in energy system in Montenegro. We are interested to see behavior of baseload in Montenegro and how this demand can be fitted with different types of renewable energy sources.

In the field of RES we are also interested for modeling of low frequent noise generated with wind turbines. This renewable energy source devices produce noise caused by turbulent flow and can affect leaving creature and birds in near surrounding. Our mission is to build a comprehensive models and have a basic knowledge to response on this important issue in next couple of decades.

Ph.D. Thesis: "Analysis of Phase Change Phenomena in Multicomponent Systems with Aspects of Technical Applying"

M.S. Thesis: "Analysis of ice making and melting processes by using modify "enthalpy method", in ice storage systems"

References

USA

1. Satya N. Atluri, Distinguished Professor, at the Department of Mechanical Engineering at Texas Tech University, Texas, USA.
2. Vaughan R. Voller, Professor, Department of Civil, Environmental and Geo - Engineering University of Minnesota, Minnesota, USA
3. Matthew J. M. Krane, Associate Professor, Materials Engineering, Purdue University, West Lafayette, IN, USA
4. Velimir Radmilović, Professor, National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

SLOVENIA

1. Dr Božidar Šarler, Professor, University of Nova Gorica, Laboratory for Multiphase Processes, Slovenia (<http://www.p-ng.si/en/research/multiphase-processes/>)

SERBIA

1. Dr Dimitrije Voronjec, Professor, Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Yugoslavia
2. Dr Milovan Studović, Professor, Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Yugoslavia

MONTENEGRO

1. Dr Petar Vukoslavčević, Professor, Faculty of Mechanical Engineering, University of Montenegro, Podgorica, Yugoslavia
2. Dr Nenad Kažić, Professor, Faculty of Mechanical Engineering, University of Montenegro, Podgorica, Yugoslavia

Research Activity

Over the past 27 years, I have conducted studies about:

- Modeling of two-phase flow (water-steam) in evaporator channels with couple of different mathematical models,
- Phase change phenomena in ice water system using modify "enthalpy" method for describing energy balance equation,
- Phase change phenomena during the solidification of two and three component alloys with special attention on Al-Cu-Mg alloy,
- Modeling of heat transfer in vertical U type heat exchangers,
- Modeling of dynamic behavior toward the zero energy buildings,

During the undergraduate study and for graduate work I have developed different mathematical models for predicting heat and mass transfer in evaporator channels. The most simply model treat two phase mixture as homogenous, but it can be successfully used for calculating the pressure drop and temperature profiles in 1-D channels through the time. Most advanced model of characteristics has been developed also, and it can be successfully used for predicting fast heat and mass transfer processes in evaporator channels. Those phenomena occur in many technical systems (steam generators, heat exchangers, and steam boilers) during the accident, which happens under the undesirable conditions.

During the Master degree study I made efforts to developing mathematical and numerical models for describing phase change phenomena in ice water system. Transport phenomena during the phase change in ice water system are important in many systems of latent energy storage, which is commonly used for energy saving in processes that demand low energy consumption. Mathematical model for describing phase changes phenomena in ice water that's developed treat problem as 2-D unsteady. An energy balance equation is written with enthalpy instead of temperature, and special algorithm is developed for calculating local temperature and fraction of solid and liquid, knowing mixture enthalpy. Isothermal character of phase change phenomena was a main difficulty in order to get temperature and mass fraction of solid phase field from mixture enthalpy, known from governing equations.

During my Ph.D. study, I worked on mathematical and numerical modeling of transport phenomena in ternary Al-Cu-Mg alloy as multi-component system. Macrosegregation i.e. redistribution of alloying elements which occurs in ingot scale is usually induced by a relative movement of both solid and liquid phase during the casting process, and can be successfully described with standard set of transport equations (mass, momentum, energy and concentration). As a constitutive correlation for macroscopic set of equations, generic ternary phase diagram of ternary Al-Cu-Mg alloy and appropriate microsegregation model has been implemented. This microscopic model was used to compute local temper-

atures, solid and liquid fractions and compositions of both alloying elements. The different sets of equations were used for primary and subsequent solidifications. The non-equilibrium in primary phase is enforced as well as diffusion that is modeled 1-D planar model. Compositional profiles of Cu and Mg in primary, secondary and ternary phase can be calculated with represented model, as well as ratio between phases and diffusion of Cu and Mg in primary phase.

After finishing of my Ph.D. dissertation the main research is focused on experimental validation of macro and micro modeling of ternary Al alloys. Experimental installation is composed from metal mold, electrical heaters and water-cooled heat exchanger for heat removal during the casting. Temperature measurements have been performed at the all six sides of mold, while the measurements inside the mold are taken too. Aluminum based *Al-4wt%Cu-1wt%Mg* alloy was cast couple of times and temperature and compositional measurements have been cut and compared with predicted values. Also, alloy *Al-32wt%Cu-2wt%Mg* is also cast with similar conditions as previous mentioned. The purpose of those experiments is to evaluate model that was developed during my PhD study. Some of these results have been published at EURO THERM 69 Conference, held in Slovenia 2003.

During the period 2004 – 2008 I participated in two separate projects in the frame of scientific cooperation with Slovenian institutions (University of Nova Gorica), and we successfully worked on developing of microsegregation codes for ternary commercial alloys (Al-Cu-Mg, Al-Mg-Si, Al-Fe-Si) which are of interest of company IMPOL d.d (www.impol.si) from Slovenska Bistrica. The all developed codes were successfully implemented in well known macroscopic mixture models and codes for vertical (VDC) and horizontal (HDC) casting of ternary aluminum alloys.

Teaching Experience

At the Faculty of Mechanical Engineering and Faculty of Metallurgy and Technology at University of Montenegro I have taught as an Assistant the following graduate courses:

- Thermodynamics
- Refrigeration systems,
- Steam Boilers,
- Heating and Ventilation,
- Fluid Mechanics.

After finishing my Ph.D. work after I was promoted in Assistant Professor I started teach two new established courses:

- Numerical Heat Transfer and Fluid Flow;
- Measuring and Simulations of Energy Processes;

These courses were performed for a first time at the Faculty of Mechanical Engineering in school year 2003/2004.

After 2006 I started teach

- Air conditioning at the Faculty of Mechanical Engineering;
- Thermodynamics at Maritime faculty in Kotor.

Igor Vušanović - Publications

A. Paper published or submitted for publishing in international review journals

1. B. Hrnčić, A. Pfeifer, F. Jurić, N. Duić, V. Ivanović, I. Vušanović, "Different Investment Dynamics in Energy Transition Towards a 100% Renewable Energy System", *Energy*, 237 (2021) 121526, <https://doi.org/10.1016/j.energy.2021.121526>.
2. I. Vušanović, V. R. Voller, "Reduced Complexity Solidification Models", *Int. Journal of Heat and Mass Transfer*, 169 (2021) 120923, <https://doi.org/10.1016/j.ijheatmasstransfer.2021.120923>.
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14. J. D. Jovanović, E. M. Tombarević, I. C. Vušanović, "Control volume finite element method for modeling of spur gear frictional heat", (2013), *Technics Technologies Education Management - TTEM*, Vol. 8, No 2. 5/6.

15. I. Vušanović, M. J. M. Krane, "Macroseggregation in horizontal direct chill casting of ternary Al alloys: Investigation of solid motion", *IOP Conference Series: Materials Science and Engineering* 27 (2012) 012069.
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B. Papers published in national Yugoslav journals (in Serbian; abstract in English)

1. M. Šekularac, I. Vušanović, "Dinamika sistema toplotne pumpe sa klima – komorom u rashladnom režimu rada", *KGH*, No. 3/2008, pp. 27 – 44, (2008).
2. I. Vušanović, M.J.M. Krane, "Matematički model mikrosegregacije u u Al-Cu-Mg leguri sa promjenljivim koncentracijama tokom očvršćavanja", *Termotehnika*, No. 1–4 Vol. 27 (2001), pp. 25–36.
3. V. Asanovic, B. Perovic, Z. Markovic, I. Vušanović, A. Kostov, "The influence of heat treatment on shape memory effect, *Journal of Technique*, No. 3/1999, Belgrade, 1999.
4. I. Vušanović, "Numerical modeling of phase change phenomena in ice – water system by using modify enthalpy method", *Thermal Science – Journal of Heat Transfer Engineers*, No. 1-4/1998, Belgrade, 1998.
5. I. Vušanović, "Mathematical modeling of phase change phenomena in two component system, based on enthalpy approach", *Journal - Process Technique*, No. 2-3/1998, Belgrade, 1998.
6. N. Kazic, I. Vušanović, "The Phenomena of ice making process in ice storage systems", *KGH*, No. 2/1995, Belgrade, 1995.

C. Papers published in the proceedings or international conferences (in English)

1. I. Vušanović, "Challenges in modeling of solid movement in solid-liquid phase change systems", *ICCES: International Conference on Computational & Experimental Engineering and Sciences, January 6 – 10th, 2021, Phuket, Thailand.*
2. B. Hrnčić, A. Pfeifer, V. Ivanović, I. Vušanović, "Energy transition towards achieving a 100% renewable energy system: Case study of Montenegro", *4th SEE SDEWES conference, Sarajevo, Bosnia & Herzegovina, June 2020.*
3. M. Pireci, I. Vušanović, V. Ivanović "Analysis of use of different standards for estimations of energy efficiency measures in building sector, *4th SEE SDEWES conference, Sarajevo, Bosnia & Herzegovina, June 2020.*
4. J. Coleman, I. Vušanović, and M. J. M. Krane, "Characterization of the 3D Flow Field and Macro-segregation in Horizontal Direct Chill Cast Slabs", *5th International Conference on Advances in Solidification Processes – ICASP5, Salzburg, Austria, June 2019.*
5. M. Đekić, E. Tombarević and I. Vušanović, "Long term performance of building with vertical ground coupled heat pump system, *In P. Gvero (Ed.) Book of Abstracts of the 14th International Conference on Accomplishments in Mechanical and Industrial Engineering DEMI, May 24 – 25th, 2019, Banja Luka, Bosnia and Herzegovina.*
6. I. Vušanović, VR Voller, "Numerical Modeling of Solid Movement in Phase Change Processes", *ICCES: International Conference on Computational & Experimental Engineering and Sciences, March 25 – 28th, 2019, Tokyo, Japan.*
7. E. Tombarević, I. Vušanović "Experimental validation of a quasy-3D CVFEM model of borehole heat exchangers", *Fourth International Conference on Computational Methods for Thermal Problems, THERMACOMP 2016, July 6-8, 2016, Georgia Tech, Atlanta, USA, N. Massarotti, P. Nithiarasu and Y. Joshi (Eds.)*
8. I. Vušanović, "Transient permeability in macrosegregation of static casting in binary al-loys: Use of CDF statistical model for analysis ", *Modeling of Casting, Welding and Advanced Solidification Processes (MCWASP XV 2015) Awaji Island, Japan, June 2015.*
9. I. Vušanović, V. R. Voller, "Simple metrics for verification and validation of macrosegregation model predictions", *4th International Conference on Advances in Solidification Processes, Beaumont Estates, Old Windsor, UK, 2014.*
10. I. Vušanović, V. R. Voller, "Effect of domain size on grid convergence in numerical models of alloy solidification", *Third International Conference on Computational Methods for Thermal Problems, THERMACOMP 2014, June 2-4, 2014, Lake Bled, Slovenia, (N. Massarotti, P. Nithiarasu and B. Šarler (Eds.)*
11. E. Tombarević, I. Vušanović, "Numerical Model of Heat flow in a Geothermal borehole heat exchanger ", *Third International Conference on Computational Methods for Thermal Problems, THERMACOMP 2014, June 2-4, 2014, Lake Bled, Slovenia, (N. Massarotti, P. Nithiarasu and B. Šarler (Eds.)*
12. B. Šarler, A. Z. Lorbiecka, U. Hanoglu, R. Vertnik, I. Vušanović, "A meshless slice model for continuous casting and hot rolling of steel. " V: LIU, Gui-Rong (ur.), LIU, Z. S. (ur.). Proceedings of the 5th Asia Pacific Congress on Computational Mechanics (APCOM2013) and 4th International Symposium on Computational Mechanics (ISCM2013), 11th -14th December 2013, Singapore.
13. I. Vušanović, V. R. Voller, "Understanding channel segregates in numerical models of alloy solidification: A case of converge first and ask questions later ", *The 6th International Conference on Solidification and Gravity, Miskolc Lillafured, Hungary, 2 – 6th September 2013.*

14. B. Šarler, R. Vertnik, A. Z. Lorbiecka, U. Hanoglu, I. Vušanović, "An Extended Heat and Mass Transfer Slice Model for Continuous Casting of Steel", *ECCOMAS Special Interest Conference Numerical Heat Transfer*, Gliwice-Wrocław, Poland, 4-6 September 2012. Eds.: A. Nowak, R.A. Biątecki
15. E. Tombarević, I. Vušanović, "Control Volume Finite Element Method for two and three dimensional advection-diffusion problems", *ICCES Special Symposium on Meshless & Other Novel Computational Methods*, Budva, Montenegro, September 2012.
16. B. Šarler, R. Vertnik, A. Z. Lorbiecka, I. Vušanović, B. Senčič, "A multiscale slice model for continuous casting of steel", *Modeling of Casting, Welding and Advanced Solidification Processes (MCWASP XIII 2012)*, Schladming, Austria, June 2012
17. I. Vušanović, R. Vertnik, B. Šarler, "A simple slice model for prediction of macrosegregation in continuously cast billets: influence of different solid diffusion models", *International symposium on liquid metal processing and casting, LMPC*, Nancy, France, September, 2011
18. I. Vušanović, R. Vertnik, B. Šarler, "A simple slice model for prediction of macrosegregation in continuously cast billets", *3rd International Conference on Advances in Solidification Processes*, Rolduc Abbey/Aachen, Germany, June 2011
19. I. Vušanović, M. J. M. Krane, "Macroscopic segregation in horizontal direct chill casting of ternary Al alloys: Investigation of solid motion", *3rd International Conference on Advances in Solidification Processes*, Rolduc Abbey/Aachen, Germany, June 2011
20. E. Tombarević, I. Vušanović, "3D Numerical model of the borehole heat exchanger", *Slovenian-Italian Conference on Materials and Technologies for Sustainable Growth*, University of Nova Gorica, Ajdovščina, Slovenia, May 2011
21. I. Vušanović, "Energy efficiency in building sector: solutions for heating and air conditioning in Montenegro", *Third International Conference GNP 2010*, Žabljak, Montenegro, 2010.
22. E. Tombarević, I. Vušanović, "Modelling of ice melting in horizontal annulus using enthalpy method", *First International Conference on Computational Methods for Thermal Problems*, ThermaComp 2009, Naples, Italy, 2009.
23. E. Tombarević, I. Vušanović, "Influence of inner pipe wall temperature on freezing of water in a horizontal cylindrical annulus", *EUROTHERM Nr. 84 Thermodynamics of phase change*, Namur, Belgium, 2009.
24. I. Vušanović, "Macroscopic segregation of ternary Al – 4.5wt%Cu – 1.0wt% Mg alloy in horizontal direct chill casting – implementation of non-equilibrium microsegregation model" *Proceedings of the Second International Conference on Advances in Solidification Processing*, Graz/Seggau, Austria, June 2008.
25. M. Šekularac, I. Vušanović, "Mathematical modeling of HVAC installations", *Klima Forum 2007*, Godovič, Slovenia, September 2007
26. I. Vušanović, I. Vujošević, "Energy efficiency strategy in Montenegro – implementation and challenges", *Klima Forum 2007*, Godovič, Slovenia, September 2007.
27. I. Vušanović, B. Šarler, "Modeling of micro and macro segregation in DC casting of ternary Al based alloys", *EUROMAT 2007*, Nurnberg, Germany, September 2007.
28. I. Vušanović, M. J. M. Krane, "Macroscopic segregation in horizontal direct chill casting (HDC) of aluminium binary alloys billets- influence of casting parameters," in *Solidification Processing 07*, H. Jones et al. (eds.), pp 428-432 (2007).
29. I. Vušanović, M.J.M. Krane, "Macroscopic segregation In Horizontal Direct Chill Casting (HDC) Of Aluminum Alloy Billets – Influence Of Casting Parameters", *Proceedings of the 5th Decennial International Conference on Solidification Processing*, Sheffield, UK, July 2007.

30. U. Karadžić, A. Bergant, I. Vušanović, "Influence of unsteady friction on transients in hydraulic pipeline systems", *12th Symposium on thermal science*, Sokobanja, Serbia, October 2005.
31. N. Kažić, I. Vušanović, "Exergy and HVAC", *Klima forum 2006*, Godovič, Slovenia, September 2006.
32. Šarler, B., Kovačević, I., Vertnik, R., Hartman, S., Vušanović, I., Založnik, M., Šafhalter, R., Slaček, E., Dragojevič, V., Jelen, M., Strnad, V., Robič, A. : Integrated numerical simulation approach in IMPOL aluminium industry casthouse, *International Conference on Aluminium in conjunction with the 6th World Trade Fair*, Essen, Germany, September, 2006.
33. I. Vušanović, B. Šarler, M.J.M. Krane, "Microsegregation during the solidification of an Al-Mg-Si alloy in the presence of back diffusion and macrosegregation", *International Conference on Advances in Solidification Processes*, Stockholm, Sweden, 2005.
34. I. Vušanović, M.J.M. Krane, "Mathematical model for microsegregation of Al rich Al-Cu-Mg alloys with considering of diffusion in primary phase", *II International Symposium LIGHT METALS AND COMPOSITE MATERIALS*, Belgrade, Serbia & Montenegro, 2004.
35. I. Vušanović, M.J.M. Krane, "Numerical and Experimental study of Macrosegregation During the Casting of Al-Cu-Mg Alloys", *EUROTHERM 69 Heat and Mass Transfer in Solid - Liquid Phase Change Processes*, Ljubljana, Slovenia, 2003.
36. V.D. Asanovic, I. Vušanović, Z.B. Markovic, A. Kostov, B. Bosnjak, B. Radulovic, "The influence of the heat treatment on martensitic transformation and properties of Cu-Zn-Al shape memory alloys", *3rd Macedonian Conference of Metallurgy*, Ohrid, 2000.
37. V.D. Asanovic, Z.B. Markovic, I. Vušanović, B. T. Bosnjak, B. Radulovic, A. Kostov, "Isothermal decomposition of β_1 phase in Cu-Zn-Al shape memory alloy", *2nd International Conference on "Chemical Sciences for Sustainable Development"*, Greece, 2000.
38. V.D. Asanovic, B. Perovic, Z. Markovic, A. Kostov, I. Vušanović, "Thermoelastic martensitic transformation and shape memory effect in Cu-Zn-Al alloys", *YUCFPCE (Yugoslav Congress of food, pharmaceutical and Chemical engineering)*, Novi Sad, 1999.
39. I. Vušanović, "Numerical modeling of phase change in ice-water system by using modify enthalpy method", *10th Symposium YU - TERM '97*, Zlatibor, 1997.
40. I. Vušanović, N. Kažić, "One numerical approach to the process in the ice storage device", *12th International Congress of Chemical and Process Engineering - CHISA '96*, Prague, 1996.
41. I. Vušanović, V. Stevanovic, M. Studovic, "Transferring of waves in evaporator channel with disturbances of intake fluid flow", *24th Congress KGH*, Belgrade, 1993.
42. I. Vušanović, V. Stevanovic, M. Studovic, "Mathematical model of forced and natural circulation - Modular approach", *23rd Congress KGH*, Belgrade, 1992.

D. Papers published in the proceedings of domestic conferences (in Serbian)

1. Karadžić, U., Bergant, A., Vušanović, I. "Validacija konvolucijskog modela nestacionarnog trenja za prelazne procese u hidrauličkim cijevnim sistemima", *30. HIPNEF sa međunarodnim učešćem 24-26 maj*, Vrnjačka Banja, Srbija, 2006.
2. V.D. Asanovic, B. Perovic, Z. Markovic, I. Vušanović, "Aging effect on shape memory in Cu-25.38Zn-3.3Al", *XXXIX Meeting of Serbs Chemical Society*, Belgrade, 1999.
3. V. Asanovic, B. Perovic, Z. Markovic, I. Vušanović, A. Kostov, "The influence of heat treatment on shape memory effect", *YUCOMAT '99*, Herceg Novi, 1999.

4. I. Vušanović, N. Kazic, "Analysis of ice making process with various regimes of work of ice storage and their influence on efficiency of system", *Industrial Energetics '96*, Herceg Novi, 1996.
5. I. Vušanović, "Model simulation of thermohydraulic instabilities in two phase flow", *Symposium "Thermohydraulics '94"*, Belgrade, 1994.
6. N. Kazic, I. Vušanović, "Processes of making and melting of ice in ice storage systems", *Industrial Energy '94*, Belgrade, 1994.
7. I. Vušanović, N. Kazic, "Numerical Modeling of natural convection in Thermal Cavity", *Industrial Energy '94*, Belgrade, 1994.

E. International & National Scientific Projects on which I. Vušanović participated

1. I. Vušanović, V. R. Voller, M. Valant, E. Tombarević, "Numeričko i eksperimentalno istraživanje mogućnosti korišćenja geotermalne energije za potrebe rada geotermalnih toplotnih pumpi", Ministarstvo nauke Crne Gore, 2012 – 2015.
2. I. Vušanović, B. Šarler, "Modelling of industrial solidification processes under influence of electromagnetic fields", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science, Education and sport of Slovenia, BI – SCG/2014 – 2015*.
3. V. Novaković, M. Vukčević, I. Vušanović, "HERD QIMSEE – Higher Education Research & Development – Quality Improvement in Science, Engineering and Education, Financed by Norwegian Ministry of foreign affairs with NTNU University, Trondheim, 2014 – 2016.
4. I. Vušanović, W. Chen, "Implementation of fast meshless simulations methods on solid mechanics and heat transfer problems in large scale structures", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science of China, in the frame of Montenegrin - Chinese Science & Technology cooperation BI – CHN/2014 – 2016*.
5. I. Vušanović, B. Šarler, "Advanced modeling of continuous casting of steel", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science, Education and sport of Slovenia, BI – SCG/2012 – 2013*.
6. I. Vušanović, B. Šarler, "Multiscale modeling of continuous casting of steel", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science, Education and sport of Slovenia, BI – SCG/2010 – 2011*.
7. I. Vušanović, B. Šarler, "Modeling of micro and macrosegregation of ternary aluminium alloys obtained through DC casting and twinroll casting", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science, Education and sport of Slovenia, BI – SCG/06-07*.
8. I. Vušanović, B. Šarler, "Modeling of phase change phenomena in Al alloys", *Financed and supported by Ministry of Science of Montenegro and Ministry of Science, Education and sport of Slovenia, BI – SCG/04-05*.
9. D. Gobin, B. Šarler, I. Vušanović, "Advances in simulation capabilities for solidification systems", *Programme ECO-NET 2005*.
10. I. Vušanović, "Development of ternary microsegregation models for direct-chill casting and twin-roll strip casting of Al based alloys, *IMPOL d.d., 2004*.
11. I. Vušanović, "Measuring and Simulation of Energetic Processes", *CDP+ Project No. 011 (2) supported and financed by WUS Austria, 2005*.

F. Graduate students supervisions

F.1 Master thesis – Advisor (A) and Committee member (M)

1. Maliq Pireci, "Uporedna analiza proračuna korišćenjem standarda MEST EN ISO 13790 i software-a RETScreen za potrebe analiza energetske efikasnosti objekata", University of Montenegro, Faculty of Mechanical Engineering, December 2019. (A).
2. Marko Đekić, "Energy use analysis of residential building equipped with heat pumps in Montenegro", University of Montenegro, Faculty of Mechanical Engineering, October 2017. (A).
3. Esad Tombarević, "Modelling of phase change in ice storage with horizontal pipe", University of Montenegro, Faculty of Mechanical Engineering, March 2009. (A).
4. Milan Šekularac, "Analysis of dynamic of operation of a HVC system heat pump – air conditioning unit", University of Montenegro, Faculty of Mechanical Engineering, July 2008. (A)
5. Uroš Karadžić, "Analysis fluid transients phenomena in hydraulic systems", University of Montenegro, Faculty of Mechanical Engineering, October 2004. (A)
6. Sanja Radović, "Investigation of controlled cooling in continuous rolling of iron bars", University of Montenegro, Faculty of Metallurgy and Technology, University of Montenegro, December 2004. (M)

F.2 Ph.D thesis – Advisor (A) and Committee member (M)

7. Boris Hrnčić, "Mathematical modelling and multi-criterion optimization of transient heat transfer in building sector in Montenegro", PhD thesis, University of Montenegro, Faculty of Mechanical Engineering, in progress.... (A)
8. Vidosava Vilotijević, "Numerical simulations and field data analyses of aerodinamical noise generation by wind turbine, PhD thesis, University of Montenegro, Faculty of Mechanical Engineering, in progress.... (A)
9. Esad Tombarević, "Analysis of unsteady heat transfer in the geothermal u-tube bore-hole heat exchangers" PhD thesis, University of Montenegro, Faculty of Mechanical Engineering, July 2016. (A)
10. Uroš Karadžić, "Modelling of complex boundary conditions for transients in hydraulic systems", University of Montenegro, Faculty of Mechanical Engineering, November 2008. (M)

G. Lectures

1. I. Vušanović, "Horizontal direct chill castings of aluminum alloys: challenges and perspectives ", University of Ljubljana, Faculty of Mechanical engineering, September 2019 (invited lecture).
2. I. Vušanović, "Current Challenges in Modeling Solidification Processes", Warren Lecture Series at Department of Civil, Environmental and Geo – Engineering, University of Minnesota, September 2017 (invited lecture).
3. I. Vušanović, "Modeling issues in transport phenomena with phase change in multi-component systems ", Nanjing University, February 2014 (invited lecture)
4. I. Vušanović, " Micro and Macrosegregation during the DC casting in ternary Al", University Pierre & Marie CURIE, Fast Laboratory, September 2006, (seminar);
5. I. Vušanović, "Micro-macrosegregation in ternary alloys - review of previous work and

- future challenges”, University of Birmingham, School of Engineering, June 2006, (invited lecture);
6. I. Vušanović, “Numerical and experimental modeling of macrosegregation in ternary aluminum alloys, Nova Gorica Polytechnic, March, 2004 (invited lecture)

H. Strategies Expertise on which I. Vušanović participated as an author or co - author (on serbo-croatian)

1. N. Kažić, P. Vukoslavčević, D. Ivanović, I. Vušanović, U. Karadžić, V. Ivanović, E. Tombarević, M. Šekularac, “Elaborat za rješavanje problema zagadjenosti u Pljevljima, Centar za Energetiku, Mašinski fakultet UCG, Jun 2015.
2. I. Vušanović, “Crna Gora u XXI stoljeću u eri kompetitivnosti, Podprojekat ENERGIJA, Crnogorska Akademija Nauka i Umjetnosti (CANU), Podgorica, April 2010 (u izradi).
3. H. Birkeland, K. O. Nerland, V. Rodić Igor Vušanović, “Montenegro - Prestudy Energy Efficiency and Renewable Energy Agency in Montenegro”, *NORSK ENERGY*, Project No. 04 - 28499, April 2008.
4. I. Vujošević, I. Vušanović, F. Daganand, “Energy Efficiency Strategy for Montenegro with action plan for 2005 - 2006”, *Technical assistance to the Ministry of Economy and EPCG*, Podgorica, April 2005.
5. I. Vušanović, V. Čulafić, R. Bulatović, D. Bajić, M. Janjić, “Elaborat Stručne Komisije u Vezi havarije na Autoklavu Ra15 u Fabrici Glinica u KAP-u”, *Mašinski fakultet Univerziteta Crne Gore*, Podgorica, Novembar 2004.

I. Monography. Books on which I. Vušanović participated as an author, co - author and editor

1. S. N. Atluri, I. Vušanović (eds), “Computational and Experimental Simulations in Engineering”, *Mechanisms and Machine Science 97, Proceedings of ICCES 2020. Volume 2*, SPRINGER Nature, 2021. ISSN: 2211-0984 <https://doi.org/10.1007/978-3-030-67090-0>
2. S. N. Atluri, I. Vušanović (eds), “Computational and Experimental Simulations in Engineering”, *Mechanisms and Machine Science 97, Proceedings of ICCES 2020. Volume 1*, SPRINGER Nature, 2021. ISSN: 2211-0984, <https://doi.org/10.1007/978-3-030-64690-5>
3. I. Vušanović, M. Janjić, V. Lubarda, “50 godina Mašinskog fakulteta Univerziteta Crne gore: 1970 - 2020, *Univerzitet Crne Gore Cetinjska br. 2*, ISBN 978-9940-527-54-9, Podgorica, 2020.

Curriculum Vitae

Name and surname: Vedran S. Perić
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Date of Birth: 30.05.1984.
Residence: Münchner Straße 4a,
85375, Neufahrn b. Freising,
Bavaria, Germany
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Education

- 2016. **PhD Degree in Electrical Engineering, KTH Royal Institute of Technology, Stockholm, Sweden**, School of Electrical Engineering, Electric Power Systems (EPS) division. Joint degree of KTH Royal Institute of Technology, TU Delft and Comillas Pontifical University.

Thesis title: "Non-intrusive methods for mode estimation in power systems using synchrophasors" ([available online](#)).

- 2011. **Master's Degree** in Electrical and Computer Engineering (MSECE), University of Novi Sad, Novi Sad, Faculty of Technical Sciences, **Power Electronics and Electrical Machines** program, average grade (9.65 /10.00).
- 2008. **Master's Degree** in Electrical and Computer Engineering (MSECE), University of Novi Sad, Novi Sad, Faculty of Technical Sciences, **Power Systems Engineering** program, average grade (9.71/ 10.00).

Experience

- **01.09.2019. Head of Research Center for Combined Smart Energy Systems**
Technische Universität München, Munich School of Engineering, Munich, Germany

Main responsibilities:

- Management and co-supervision of a group of doctoral students
- Management of laboratory for combined smart energy systems (the laboratory assets exceeds 2mln euros)
- Preparation of research project proposals and project execution with cost control
- Support in laboratory exercises in courses organized by Munich School of Engineering
- Research topics: Modeling, operation and control of integrated energy systems (electric, heat/cooling and transportation)

• **01.08.2017. – 31.08.2019. Senior Power System Consultant**

GE Energy Consulting, Munich, Germany

As a consultancy firm, the core business was to provide power system expertise to utilities and energy companies. Considering the scale of typical consultancy projects (small or medium size), the power system consultant role assumes full and exclusive ownership of the project cycle, from business development, project proposals, cost control to project execution.

Main responsibilities:

- Continuously searching for opportunities and customers to provide consultancy services
- Preparation of project scope and financial proposal
- Project management with project execution and cost control
- Continuously developing personal skills which are aligned with market trends and needs

• **01.12.2016 – 31.07. 2017. Senior Business Analyst**

TSCNET Services GmbH, Business Development Team, Munich, Germany

Main responsibilities:

- Development of processes for cross-border TSO coordination including concepts, methodologies, business requirements and procedures.
- Development of prototype tools (Matlab) that demonstrate benefits of the proposed TSO coordination.
- Specification, guiding and supporting industrial software development projects.
- Marketing. Promotion of the technical solutions through conferences/workshops/trainings attendance.

• **04.04.2016 – 15.11. 2016. Senior Power System Engineer/Business Analyst**

Alstom Grid UK Limited (GE Grid Solutions), R&D department, GE WAMS Center of Excellence, Edinburgh, UK.

Main responsibilities:

- GE Technical lead of the government funded innovation project – FITNESS (Future Intelligent Transmission Network SubStation)
- Development (business analysis) of the PhasorPoint WAMS software solution

• **12.09.2011. – 03.04.2016. PhD Student** Erasmus Mundus SETS Joint Doctoral Program.

Home University: **KTH Royal Institute of Technology, Stockholm, Sweden.**

Secondary University: TU Delft, Delft, Netherlands. Guest researcher: 01.10.2013-30.06.2014. Faculty of Mechanical, Maritime and Materials Engineering (3mE), Delft Center for Systems and Control (DCSC).

Tertiary University: Comillas Pontifical University, Madrid, Spain.

• **01.10. 2008 - 31.8.2011. Power System Engineer**

Telvent DMS LLC, Novi Sad, Serbia (present day **Schneider Electric DMS NS**). In addition, I held a part time role (10% of the time) as Research and Teaching assistant at the University of Novi Sad, Faculty of Technical Sciences.

Main responsibilities:

- Development of the DMS and EMS software solutions (Power Flow, State Estimation, Distributed Generation Management, AGC)
- Power System Modelling (integration with GIS systems, CIM modeling etc)
- Project Delivery of the smart grid projects with the focus on implementation of Distribution Management System (DMS)
- DMS Customer Trainings
- Teaching Power System Modeling Course at the University of Novi Sad

Languages

- English, Serbian and basic German (B1)

Skills

Summary:

I have expertise in power utility operations combined with the knowledge of software engineering and strong background in mathematics, signal processing, control theory and system identification.

Skill set:

- Programming languages (Python, Matlab, Visual Basic, C++, Fortran, G)
- Mathematics (optimization, differential equations, algebra)
- Data Analysis (Signal Processing, System Identification, Control Theory, Artificial Intelligence, Machine Learning)
- Power system modeling and simulations
- Modeling of integrated energy systems
- Real-time monitoring and control of power systems (Wide Area Monitoring Systems (WAMS), Energy and Distribution Management Systems (EMS/DMS), SCADA (Supervisory control and data acquisition) systems)
- Real-time simulations (Opal-RT, NI Veristand)
- Project management
- Business development

Most Important Projects

- Implementation of smart grid in **Hydro One** network, **Ontario, Canada**. Position: Deputy team lead responsible for integration of distributed renewable generation. Period: 2010-2011.
- Implementation of automatic generator control and economic dispatching for **Petroproduction, Ecuador**. Position: Algorithm and Software Developer. Period: 2008-2010.
- Development of EMS solution (transmission state estimation and contingency analysis) for **Emasz Utility, Hungary**. Position: Algorithm and Software Developer. Period: 2009-2011.

- **FP7 iTesla** project - Innovative Tools for Electrical System Security within Large Areas. Position: Researcher. Period: 2012-2016.
- **FITNESS** Ofgem Innovation project (Future Intelligent Transmission Network SubStation). Position: GE technical lead for monitoring and control applications. Period: April 2016- December 2016.
- Emirates Global Aluminum Refinery – Modeling and analysis of the newly built refinery (3000MW of installed capacity). Position: Senior Power System Consultant.
- Saudi Aramco – Islanding study for Qatif Power Plant. Position: Senior Power System Consultant.
- Ras Shukeir – Development of Power Management System (PMS) logic. Position: Senior Power System Consultant.

Other Professional Activities

- Member of IEEE Power & Energy Society.
- Organization of Workshop on Synchrophasors and Control Applications for Power Systems, March 16, 2016, Stockholm, Sweden.
- Moderator (chair) of a paper forum session at IEEE PES General Meeting, Boston, MA, USA, 17-21 July 2016 (Paper Forum 2).
- Organizer and chair of a special session at IEEE PES PowerTech Conference, June 18-22, 2017, Manchester, UK. Session title: "Industry perspective on Synchrophasor technology".
- Chair of the Best Paper Session at the IEEE PES General Meeting, July 16-20, Chicago, USA
- Organizer of the tutorial on EMS and Voltage Control at the IEEE PES GM 2018,
- Member of the Technical Committee for IEEE PES ISGT Europe 2018 Conference.
- Journal Reviewer:
 - IEEE Transactions on Power Systems (ISSN: 0885-8950);
 - IEEE Transactions on Sustainable Energy (ISSN: 1949-3029);
 - IET Generation, Transmission and Distribution (ISSN: 0143-7046);
 - Control Engineering Practice (ISSN: 0967-0661);
 - Electric Power System Research (ISSN: 0378-7796)
 - International Journal of Electrical Power & Energy Systems – IJEPES (ISSN: 0142-0615);
 - Serbian Journal of Electrical Engineering - SJEE (ISSN: 1451-4869);
 - Tehnika (ISSN: 0040-2176).
- Conference Reviewer:
 - IEEE Power and Energy Society General Meeting
 - Power Systems Computation Conference
 - International Modelica Conference
 - Power and Energy Conference at Illinois
 - Power Systems Conference at Clemson University
 - IEEE PES PowerAfrica Conference 2017

Awards and grants

- TUM Seed Grand for H2020 project proposal preparation, 2019
- Two times awarded for results in regional students tournaments in Power System Analysis and Electrical Machines,

- Four times awarded by Faculty of Technical Sciences for accomplishments during studies,
- SETS Erasmus Mundus Fellowship grant, 2011,
- IntellICIS Grant, 2016,
- Three times awarded the KTH EES travel grant.

Interests and hobbies

- Innovation Management and Marketing,
- Stock Exchange Trading and Macroeconomics,
- Human Rights and Democracy,
- Social Networking,
- Swimming and Cycling,
- Traveling,
- Everything related to aviation industry.

Publications and Presentations:

Journal Papers:

- T. Kamal, M. Karabacak, V.S. Perić, S.Z. Hassan, L.M. Fernández-Ramírez, L, "**Novel Improved Adaptive Neuro-Fuzzy Control of Inverter and Supervisory Energy Management System of a Microgrid**", *Energies* 2020, 13(18), 4721.
- Luan F.S. Colombari, Roman Kuiava, Vedran S. Perić, Rodrigo A. Ramos, "**Continuation Load Flow Considering Discontinuous Behaviors of Distribution Grids**". *IEEE Transactions on Power Systems*, vol. 34 , no.5 , Sept. 2019.
- Tetiana Bogodorova, Luigi Vanfretti, Vedran S. Perić, Konstantin Turitsyn, "**Identifying Uncertainty Distributions and Confidence Regions of Power Plant Parameters**", in *IEEE Access*, vol. 5, pp. 19213-19224, 2017.
- Vedran S. Perić, Xavier Bombois and Luigi Vanfretti, "**Optimal Signal Selection for Power System Ambient Mode Estimation using a Prediction Error Criterion**", *IEEE Transactions on Power Systems*, vol.31, no.4, pp.2621-2633, July 2016.
- Vedran S. Perić and Luigi Vanfretti, "**Power System Ambient Mode Estimation Considering Spectral Load Properties**", *IEEE Transactions on Power Systems*, vol.29, no.3, pp.1133-1143, May 2014.
- Vedran S. Perić, Andrija T. Sarić and Dejan I. Grabež, "**Coordinated Tuning of Power System Stabilizers based on Fourier Transformation and Neural Networks**", *Electric Power Systems Research*, vol.88, iss.1, pp.78-88, July 2012.

Non-ISI Journal Papers:

- Tijana Šćuk, Pavle Savković and Vedran S. Perić, "**Realization of simulation framework for Oasys SCADA application development using Simulink toolbox**", *Zbornik radova FTN*, vol.25. iss.5, pp.1038-1041, 2010. (in Serbian).
- Vedran S. Perić and Andrija T. Sarić, "**Small signal stability enhancement using power system stabilizers**", *Elektroprivreda*, vol.63, iss.3, pp.272-283, 2010. (in Serbian).

Books:

- Dragan S. Popović, Zvonko Gorečan, Jugoslav Dujić, Veran Vasić and Vedran S. Perić, "**Power system modeling**", book published by DMS Group, Novi Sad, Serbia, October 2011. (in Serbian).

Conference Papers:

- Verena Kleinschmidt, Thomas Hamacher, Mohammad Reza Hesamzadeh, Vedran S. Perić, "**Unlocking Flexibility in Multi-Energy Systems: A Literature Review**", 17th International Conference on the European Energy Market (EEM), 2020. (virtual)
- Sjoerd Boersma, Xavier Bombois, Luigi Vanfretti, V. Perić, Juan Carlos Gonzalez-Torres, Roman Segur, Abdelkrim Benchaib, "**Enhanced Power System Damping Estimation via Optimal Probing Signal Design**", 22nd European Conference on Power Electronics and Applications (EPE'20 ECCE Europe), 2020. (virtual)
- Vedran S. Perić, Thomas Hamacher, Anurag Mohapatra, Franz Christiange, Daniel Zinsmeister, Peter Tzscheuschler, Ulrich Wagner, Christian Aigner, Rolf Witzmann, "**CoSES Laboratory for Combined Energy Systems At TU Munich**", IEEE PES General Meeting 2020 (virtual)

- Vedran. S. Perić, Xavier Bombois and Luigi Vanfretti, "**Optimal Multisine Probing Signal Design for Power System Electromechanical Mode Estimation**", Hawaii International Conference on System Sciences (HICSS) 2017, Waikoloa Village, HI, USA, 4-7 January 2017.
- Vedran. S. Perić and Luigi Vanfretti, "**Optimal PMU Placement for Power System Ambient Data-based Mode Estimation Applications**", IEEE PES Innovative Smart Grid Technologies (ISGT) Europe 2016, Ljubljana, Slovenia, 9-12 October 2016
- Maxime Baudette, Ravi Singh, Vedran S. Perić, Stig Løvlund and Luigi Vanfretti, "**In Silico Testing of a Real-Time PMU-Based Tool for Power System Mode Estimation**", IEEE PES General Meeting 2016, Boston, MA, USA, 17-21 July 2016.
- Vedran S. Perić, Tetiana Bogodorova, Ahmet N. Mete, Luigi Vanfretti, "**Model Order Selection For Probing-based Power System Mode Estimation**", Power and Energy Conference at Illinois, Champaign, IL, USA, 20-21 February 2015.
- Vedran S. Perić, Maxime Baudette, Luigi Vanfretti, Jan O. Gjerde and Stig Løvlund, "**Implementation and Testing of a Real-Time Mode Estimation Algorithm using Ambient PMU Data**", Power System Conference 2014, Clemson, SC, USA, 11-14 March 2014.
- Luigi Vanfretti, Vedran S. Perić and Jan O. Gjerde, "**Estimation of Electromechanical Oscillations in the Nordic Grid using Ambient Data Analysis**", IEEE PES General Meeting 2013, Vancouver, Canada, 21-25 July 2013.
- Luigi Vanfretti, Sebastian Bengtsson, Vedran S. Perić and Jan O. Gjerde, "**Spectral Estimation of Low Frequency Oscillations in the Nordic Grid using Ambient Synchrophasor Data under the Presence of Forced Oscillations**", IEEE PowerTech 2013, Grenoble, France, 16-20 June 2013.
- Luigi Vanfretti, Vemund .H. Aarstrand, Muhammad S. Almas, Vedran S. Perić and Jan O. Gjerde, "**A Software Development Toolkit for Real-Time Synchrophasor Applications**", IEEE PowerTech 2013, Grenoble, France, 16-20 June 2013.
- Luigi Vanfretti, Sebastian Bengtsson, Vedran S. Perić and J. O. Gjerde, "**Effects of Forced Oscillations in Power System Damping Estimation**", IEEE International Workshop on Applied Measurements for Power Systems (AMPS), Aachen, Germany, 26-28 September 2012.
- Vladimir Lj. Ljubojev, Vedran S. Perić, Veran Vasić and Andrija T. Sarić, "**Integration of Distributed Generation Models in Distribution Management System**", 30th Conference CIGRE Serbia, Zlatibor, Serbia, 29 May-3 June 2011. (in Serbian).
- Ljubomir Francuski, Aleksandar Selakov, Filip Kulić and Vedran S. Perić, "**One Solution of Implementation and Visualisation of Automatic Generation Control**", 14th Symposium CIGRE Serbia - Tara, Serbia, 16-18 June, 2008. (in Serbian)
- Vedran S. Perić and Filip Kulić, "**Matlab based Simulation of Interconnected Power Systems**", 14th Symposium CIGRE Serbia - Tara, Serbia, 16-18 June, 2008. (in Serbian).

Talks and presentations:

1. Oral Presentation (Invited Keynote Speaker): "**Moving forward to integrated energy systems**", NIDays Europe (National Instruments User Conference), Munich, Germany, 20-21 November 2019. ([available online](#))

2. Oral Presentation (Invited Speaker): **"TU Munich microgrid laboratory"**, NIDays Europe (National Instruments User Conference), Munich, Germany, 20-21 November 2019.
 3. Oral Presentation: **"TU Munich microgrid laboratory"**, KTH Royal Institute of Technology, Stockholm, Sweden, 14 November 2019 (invited by prof. Lars Nordström)
 4. Oral Presentation (Invited Speaker): **"Measurement-based modelling in power systems"**, International Workshop on Dynamic Stability Challenges of Future Electric Power Grids. Zurich University of Applied Sciences, 11 September 2017.
 5. Oral presentation: **"Experiences in Monitoring of sub-synchronous oscillations in the UK grid"**, Meeting of IEEE Working Group on Power System Dynamics Measurements, IEEE PES General Meeting 2016, Boston, MA, USA, 17-21 July 2016.
 6. Oral presentation: **"Optimal Signal Selection for Power System Ambient Mode Estimation using a Prediction Error Criterion"**, Transaction paper session, IEEE PES General Meeting 2016, Boston, MA, USA, 17-21 July 2016.
 7. Oral presentation: **"Synchrophasor Applications for Distribution Networks Enhancing T&D Operation and Information Exchange"**, North American Synchrophasor Initiative (NASPI), Atlanta, GA, USA. 22-24 March 2016.
 8. Oral presentation: **"Optimal Signal Selection for Power System Ambient Mode Estimation using a Prediction Error Criterion"**, Working Group on Power System Dynamics Measurements, IEEE PES General Meeting 2015, Denver, CA, USA, 26-30 July 2015.
 9. Oral presentation: **"Least Costly Probing Signal Design for Power System Mode Estimation"**, North American Synchrophasor Initiative (NASPI) Work Group meeting, San Mateo, CA, USA. 23-24 March 2015.
 10. Poster presentation: **"Optimal Signal Selection for Power System Ambient Mode Estimation using a Prediction Error Criterion"**, North American Synchrophasor Initiative (NASPI) Work Group meeting, San Mateo, CA, USA. 23-24 March 2015.
 11. Invited talk: **"Estimation of Electromechanical Modes in Power Systems Using System Identification Techniques"**, Massachusetts Institute of Technology (MIT), MA, USA. February 2015. Invited by prof. Konstantin Turitsyn.
 12. Invited talk: **"Estimation of Electromechanical Modes in Power Systems Using System Identification Techniques"**, Northwestern University, Evanston, IL, USA. February 2015. Invited by prof. Adilson Motter.
- Poster presentation: **"A Software Development Toolkit for Fast Prototyping and Testing of Real-Time Synchrophasor Applications"**, Poster presented at the Second IntelliCIS Training School, Aachen, Germany, 4-8 March 2013.

Milan ŠEKULARAC PhD mech.eng. - Curriculum Vitae

1. CURRENT POSITION

Assistant Professor at Faculty of Mechanical Engineering,
Laboratory for Fluid Mechanics and Energy Processes
University of Montenegro



First Name: MILAN
Family Name: ŠEKULARAC
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Gmail: milan.sekularac.mne@gmail.com;
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Web: <http://www.ucg.ac.me/objava/blog/17838/objava/1>
Youtube: <https://www.youtube.com/channel/UCOuNe9mBex9RTVf7Yiaw89w/videos>

2. EDUCATION

Grad and undergrad

- ❖ PhD mech. eng. „*Analysis of flow fields in complex ventilation systems of traffic tunnels*”, Mechanical Engineering Faculty, University of Montenegro, 2015;
- ❖ MSc. mech.eng. „*Analysis of the dynamics in a HVAC system consisting of heat pump with air-handling unit*”, Mechanical Engineering Faculty, University of Montenegro, 2008;
- ❖ Dipl.-Ing. mech.eng. „*Numerical simulation of heat and mass transfer in Czochralski crystal growth process under the effect of radial-axial magnetic field*”, Mechanical Engineering Faculty, University of Montenegro, 2005;

Postdocs & recent trainings

- ❖ **STANFORD UNIVERSITY Cardiovascular Biomechanics Computation (Prof. Dr Alison Marsden) CFD of blood flow**
Fulbright Visiting scholar in 2016, at the “Cardiovascular Biomechanics Computation Lab” of Prof.Dr Alison Marsden, Stanford University. Outline: 3D-CAD model generation from MRI data, boundary conditions modelling through multiscale approach, and FEA simulation of blood flow of a database of pediatric patients affected by a cardiovascular disorder (Kawasaki aneurisms on coronary arteries). The ultimate goal: better understanding of flow criteria for prescription of anticoagulation therapies, and possible surgical treatments;
- ❖ **VUB UNIVERSITY in Brussels - Combustion in Open Foam at the group BURN – Prof. Dr Francesco Contino**
Related to my interests in CFD of fire scenarios and general combustion problems in the Open Foam framework

3. RESEARCH PROJECTS

1. **Analysis of flow and fire scenarios in traffic tunnel ventilation design.** National research project lead by Prof.Dr.Petar Vukoslavčević. A combined CFD and experimental assessment of turbulent flows in ventilated tunnels, axial ducted fans, and the fire safety scenarios. Experimental research conducted on a scaled Lab. model of a ventilated traffic tunnel that I designed and built myself, equipped with appropriate scaled axial ducted fan models.
2. **Development of Hot-Wire Anemometry circuits for hot-wire measurement technology.** Lead by Prof.Petar Vukoslavčević, aimed at the development of an updated design of these circuits with optimized performance, increased frequency response, even better signal-to-noise ratios and measurement sensitivity. Applications in velocity and temperature measurements in turbulent flows. Experimental verification utilizing state-of-the-art-hot wire probes, and sensors of

- 2.5, 1 and 0.6 micrometer diameter. Optimization of the hotwire probe design through experiments and CFD.
3. **Flow fields in rotating turbomachinery.** Joint work by Laboratory for Turbomachinery and Energy Systems, University of Belgrade and my Lab. Development of laser and hot-wire anemometry measurement technology and CFD approaches to assess the complex flow fields in rotating machinery, primarily axial fans.
 4. **Undergrad research experiences.** Institute of Fluid Mechanics - LSTM, University of Erlangen - Nuremberg, Germany. A numerical simulation of heat and mass transfer in the "Czochralski" crystal growth process, under the effect of a radial-axial (cusp shaped) magnetic field, where I used a LSTM's research CFD code to compute the flow and heat transfer, the shape of the solid-liquid interface, in an industry case crucible furnace geometry.

4. LANGUAGE SKILLS

(1-basic to 5-profficient)			
Language	Reading	Speaking	Writing
Serbian-croatian-montenegrin	Native	Native	Native
English	5	5	5
Italian	5	5	4
German	1	1	1

5. SKILLS

a) General computer skills

- ❖ Text editors: Microsoft Office, LATEX, Sublime, Emacs
- ❖ Programming proficient: MATLAB / Octave / C
- ❖ Programming basic: C++ / Python
- ❖ Graphics: TecPlot, ANSYS CFD-Post, Paraview
- ❖ CAD profficient: 3D AutoCAD
- ❖ CAD basic skills: CATIA

b) CFD – Computational Fluid Dynamics

Using commercial tools:

- ❖ ANSYS Workbench CFD environment software: Ansys Mesher, FLUENT, CFX, CFD-Post post-processing

Open Source CFD tools:

- ❖ Self-written codes for numerical solution of flows with heat transfer using finite volume approach, in Matlab
- ❖ Open Foam CFD basic skills, current field of interest
- ❖ FASTEST 3D (german open source academic CFD solver) used it for flow and heat transfer simulations on a workstation computer.
- ❖ SimVascular (Stanford) for Cardiovascular biomechanics – blood flow CFD (and vessel deformation) computation FEA solver with CAD pre-and post-processing tools (Paraview), current field of interest

c) Experimental fluid dynamics, heat transfer, and HVAC skills

❖ Experimental fluid mechanics

"Hot-wire" or thermal anemometry under the guidance of Prof. Petar V. Vukoslavčević, a leading expert in the field and Lab founder. Calibration and measurements of hotwire probes for measurement of velocity (and temperature) in turbulent flows. Utilisation of in-house Fortran

codes for calibration and processing of hot-wire anemometry measurements. Self-written Matlab codes for processing of measurement data, signal-processing and graphic processing in Matlab and TecPlot. Experience in use of Data Translation's DAQ hardware and their DAQ software.

❖ **Ventilation and fire safety**

Research on flow field and fire scenarios in a Lab model of a traffic tunnel, using hot-wire probe for air-velocity, Pitot tubes, differential pressure transducers and thermocouple DAQ system. Realization of fires-scenario experiments, utilising a buthane burner and temperature DAQ equipment. CFD of tunnel-fire scenarios.

❖ **HVAC, Renewable Energy, and Energy Efficiency**

- An experimental study on a laboratory HVAC system performance and its time-dynamics. Monitoring of the characteristic temperatures within a vapour – compression cycle heat pump with an air-handling unit system. Numerical simulation of the system's performance and operation with respect to time, using a self-made MATLAB code simulating the heat pump cycle utilizing a R407C refrigerant coupled to an air handling unit operation in time.
- CFD assessment of a ground to air heat exchanger for passive heating, in the given climatic conditions of the capital city, both in summer and winter use.
- Energy use performance assessment and energy audits in buildings. Algorithms for calculation of cooling loads and energy indicators. Measurements of flow, pressure, temperature, and COP on HVAC installations. Certified energy auditor.

d) **Lecturing**

I currently teach or I've taught the following courses:

- ❖ Thermodynamics,
- ❖ Applied Thermodynamics,
- ❖ Heat and Mass Transfer,
- ❖ Numerical methods for fluid - thermo dynamics (CFD),
- ❖ Air-conditioning,
- ❖ Measurement and simulation of energy processes,
- ❖ Fluid transport
- ❖ Energy consumption and efficiency
- ❖ Introduction to engineering drawing geometry - CAD.

6. CURRENT WORK

- ❖ CFD in reactive flows: Flow in a fire scenario of a traffic tunnel, with longitudinal ventilation. Effects of radiation heat losses on temperature field development and ventilation efficiency. Multiscale approach in long tunnels, use of ANSYS solver and the Open Foam. Mixture-fraction approach in modelling reactive flow. Combustion in Open Foam.
- ❖ Hot-wire anemometry circuit design updates: experimental verifications.
- ❖ Cardiovascular biomechanics: Flows in coronary arteries. CAD model generation from MRI & CT scan medical image data. FFR computation;

7. FURHER INTERESTS

- ❖ IGA (isogeometric analysis) multiscale approaches and optimisation methods;
- ❖ Heat transfer applications

8. PUBLICATIONS

- ❖ Šekularac, B. Milan, Janković. *Experimental and Numerical Analysis of Flow Field and Ventilation Performance in a Traffic Tunnel Ventilated by Axial Fans; Theoretical and Applied Mechanics Journal, Academy of Sciences and Arts of Serbia, 2017.*

- ❖ Šekularac, B. Milan, Jankovic, Z. Novica, Vukoslavcevic, V.Petar. Ventilation Performance and Pollutant Flow in a Unidirectional Traffic Road Tunnel. *Thermal Science Journal*, DOI: 10.2298/TSCI160321117S. 2016.
- ❖ Šekularac, B. Milan. Experimental Determination of Tunnel Ventilation Ducted Fan Performance. *Thermal Science Journal*, DOI.10.2298/TSCI 140624108S. 2014.
- ❖ Šekularac, B.Milan, Vukoslavčević, V.Petar. One Approach to Experimental and Numerical Investigation of Longitudinally Ventilated Road Tunnels. *ICTTE Conference on Traffic and Transport Engineering, Belgrade*. Nov.2012.
- ❖ Šekularac, M, Radulović, P. Energy Efficiency of Ventilation Systems of Longitudinally Ventilated Traffic Tunnels (in serbian). *International conference on Alternative energy sources and energy efficiency, CANU – Montenegrin Academy of Sciences and Arts*. Oct.2011.
- ❖ Šekularac M, Tombarević E. Analysis of Geothermal Heat Exchanger „AirtoGround“ in the Climatic Conditions of Podgorica City (in serbian). *International conference on Alternative energy sources and energy efficiency, CANU – Montenegrin Academy of Sciences and Arts*. Oct.2013.
- ❖ Vukoslavčević P., Šekularac M., Wallace J., Balaras E., Berattis N. The accuracy of crossstream velocity gradients measured by a multisensor hotwire probe. *American Physical Society, 62nd Annual Meeting of the APS Division of Fluid Dynamics, Nov. 2224, 2009*.
- ❖ Tombarević E., Šekularac M. 2D Analysis of the Cooling Potential of Underground Waters of Podgorica City (in serbian). *International conference on Alternative energy sources and energy efficiency, CANU – Montenegrin Academy of Sciences and Arts*. Oct.2009.
- ❖ Šekularac M., Vušanović I. System Dynamics of a Heat Pump with Climatic Chamber in Cooling Regime of Operation (in serbian). *Journal of KGH, Serbian Society of Airconditioning, Heating and Refrigeration Engineers. Belgrade, Sept. 2008*.
- ❖ Vuksanović D., Kažić N., Šekularac M. Analysis of Energy Efficiency of One Office Building in Podgorica. *COSMO EE Conference, 2010*.

9. OTHER INTERESTS / sports / culture / volunteer /

Languages: German, Italian

Sports

- ❖ Competitor in archery, national champion, various regional, central-European, US regional, competitor and medal winner, competitor at 3 World and 1 European Championships in Target and Field archery. Competitor in several disciplines (archery styles) and tournament formats;
- ❖ Founder and currently Director of National Archery Association, Club coach;
- ❖ Alpine skiing enthusiast and hiker in mountains;
- ❖ Swimming.

Other

- ❖ Design of archery equipment (composite limbs, different components).

1. **Family Name:** Esad
2. **First Name:** Tombarevic
3. **Company:** University of Montenegro, Faculty of Mechanical Engineering
4. **E-mail:** esad.tombarevic@ucg.ac.me
5. **Date of birth:** 28.09.1983.
6. **Nationality:** Montenegrin
7. **Civil status:** Married

8. **Education**

Institution	University of Montenegro, Faculty of Mechanical Engineering
Date: from – to	2009 – 2016
Degree(s) or Diploma(s) obtained	PhD in Mechanical Engineering

Institution	University of Montenegro, Faculty of Mechanical Engineering
Date: from – to	2007 – 2009
Degree(s) or Diploma(s) obtained	MSc in Mechanical Engineering

Institution	University of Montenegro, Faculty of Mechanical Engineering
Date: from – to	2002 – 2007
Degree(s) or Diploma(s) obtained	BSc in Mechanical Engineering

9. **Language skills (1-worst to 5-best for competence)**

Language	Reading	Speaking	Writing
Montenegrin	Mother tongue		
English	5	5	5
French	2	2	2

10. **Membership of professional bodies:**

International Network on Small Hydro Power

Montenegrin Centre for Energy Efficiency (Crnogorski centar za energetska efikasnost)

11. **Other skills:**

Computer skills: Microsoft Office (Word, Excel, Power Point, Outlook); Matlab; Fortran; AutoCad; ENSI® Key Numbers Software (Specialized software for calculating the energy performance of buildings); ENSI Profitability Software for calculation of profitability of energy efficiency measures; MEEC – Montenegrin Energy Efficiency Certification software for calculation of energy need, energy use and primary energy or buildings.

Measurements: Various measurements related to energy efficiency, such as temperature and relative humidity data logging, IR thermography, lux metering, flue gas analysis, blow door testing, U value measurement etc.

12. **Present position:** Assistant professor, University of Montenegro, Faculty of Mechanical Engineering13. **Years of experience:** 2007 - present14. **Key qualifications relevant to the project:**

- Experience in research, laboratory work and on field measurements.
- Experience in the design of HVAC systems
- Teaching the university courses with focus on energy and the environment, HVAC equipment, basic principles of heating, ventilation and air conditioning
- Familiarity with eco-design and energy labeling of various HVAC equipment
- Energy auditing of buildings, energy monitoring and on field measurements.
- Certified by the Ministry of Economy of Montenegro after successfully completing the training

- program for energy auditing of buildings (September 2010)
- Certified by Norwegian energy efficiency and business development consulting company ENSI – Energy Savings International AS, as a trained trainer on ENSI Methodology for Energy Auditing of Buildings (2010)

15. Professional positions

Date: from – to	2019 – present
Location	Podgorica
Company	University of Montenegro, Faculty of Mechanical Engineering
Position	Assistant professor
Description	Assistant professor on following courses: Energy and the environment, Refrigeration, Air conditioning, Energy efficiency in buildings. Research interest in the field of heat and mass transfer, energy efficiency, energy simulation of buildings.

Date: from – to	2007 – 2019
Location	Podgorica
Company	University of Montenegro, Faculty of Mechanical Engineering
Position	Teaching and research assistant
Description	Teaching and research assistant on following subjects: Thermodynamics, Refrigeration, Heating, Steam Boilers, Applied Fluid Dynamics.

16. Scientific and research projects (national, bilateral etc.)

Date: from – to	2016 – 2018
Location	Montenegro, Serbia
Company	Ministry of Science Montenegro
Position	Active researcher
Description	Modern heat storage technologies with emphasis on thermomechanical processes modeling in heat storage systems, Bilateral scientific and research project within the framework of the program of scientific and technological co-operation between the government of Montenegro and the republic of Serbia

Date: from – to	2012 – 2015
Location	Montenegro
Company	Ministry of Science Montenegro
Position	Active researcher
Description	Numerical and experimental investigation of the possibility of use of geothermal energy for the operation of heat pumps, National scientific and research project co-financed by the Ministry of Science of Montenegro

17. Publications

Journals

- [1] R. Vujadinović, E. Tombarević, U. Karadžić, Valorization of potentials of wind energy in Montenegro, Thermal Science, Vol. 21, No. 5, pp. 1893-1903, 2017.
- [2] E. Tombarević, V. R. Voller, I. Vušanović, Detailed CVFEM algorithm for three dimensional advection-diffusion problems, Computer Modelling in Engineering and Science (CMES), Vol. 96(1), pp.1-29, 2013.
- [3] E. Tombarević, I. Vušanović, Modelling of Ice-Water Phase Change in Horizontal Annulus Using Modified Enthalpy Method, Advances in Applied Mathematics and Mechanics, Vol. 3, No. 3, pp. 354-369, 2011.

Conference proceedings

- [1] M. Đekić, E. Tombarević, I. Vušanović, Long term performance of building with vertical ground coupled heat pump system, International Conference on Accomplishments in Mechanical and Industrial Engineering - DEMI 2019, May 24-25, 2019, Banja Luka, Bosnia and Herzegovina.
- [2] D. Kovač, V. Ivanović, E. Tombarević, D. Ivanović, One way of determining immision in urban environments, 34th International Conference organized by the Association of Energy Sector Specialists of Serbia - ENERGY SECTOR 2018, March 27-30, 2018, Zlatibor, Serbia.

- [3] V. Ivanović, E. Tombarević, Modelling of PM10 immision from individual furnaces and city boiler rooms in Pljevlja, 18th Symposium on Thermal Science and Engineering of Serbia - SIMTERM 2017, October 17-20, 2017, Sokobanja, Serbia.
- [4] V. Ivanović, E. Tombarević, Contribution of thermal power plant to the immision of PM10 in the center of Pljevlja, 8th International Scientific Conference Research and Developments of Mechanical Elements and Systems - IRMES 2017, September 7-9, 2017, Trebinje, Bosnia and Herzegovina
- [5] E. Tombarević, I. Vušanović, Numerical analysis of unsteady heat transfer in U-tube geothermal heat exchanger, 13th International Conference on Accomplishments in Mechanical and Industrial Engineering - DEMI 2017, May 26-27, 2017, Banja Luka, Bosnia and Herzegovina.
- [6] E. Tombarević, I. Vušanović, Experimental validation of a quasi-3D CVFEM model of the borehole heat exchangers, 4th International Conference on Computational Methods for Thermal Problems - ThermaComp2016, July 6-8, 2016, Georgia Tech, Atlanta, USA.
- [7] E. Tombarević, I. Vušanović, Numerical model of heat flow in a geothermal borehole heat exchanger, 3rd International Conference on Computational Methods for Thermal Problems - ThermaComp2014, June 2-4, 2014, Lake Bled, Slovenia.
- [8] E. Tombarević, I. Vušanović, Control Volume Finite Element Methods for two and three dimensional advection-diffusion problems, ICCES Special symposium on Meshless and Other Novel Computational Methods, September September 2-6, 2012, Budva, Montenegro.
- [9] M. Šekularac, E. Tombarević, Analysis of ground-air heat exchanger in the climatic conditions of Podgorica, 8th International Scientific Meeting: Renewable Energy Sources and Energy Efficiency, October 8-9, 2013, Podgorica, Montenegro.
- [10] E. Tombarević, I. Vušanović, Numerical Model of Borehole Heat Exchanger, Slovenian-Italian Conference on Materials and Technologies for Sustainable Growth, May 4-6, 2011. University of Nova Gorica, Ajdovščina, Slovenia.
- [11] E. Tombarević, M. Šekularac, 2D analysis of cooling potential of groundwaters of Podgorica, 6th International Scientific Meeting: Alternative Sources of Energy and Future of their Application, October 8-9, 2009, Budva, Montenegro.
- [12] E. Tombarević, I. Vušanović, Modeling of ice melting in horizontal annulus using enthalpy method, 1st International Conference on Computational Methods for Thermal Problems ThermaComp2009, September 8-10, 2009, Napoli, Italy.
- [13] E. Tombarević, I. Vušanović, Influence of inner pipe wall temperature on freezing of water in a horizontal cylindrical annulus, EURO THERM Seminar Nr.84 Thermodynamics of Phase Change, May 24-27, 2009, Namur, Belgium.

Thesis (PhD. and MSc)

- [1] E. Tombarević, Analysis of unsteady heat transfer in geothermal borehole U tube heat exchangers, PhD thesis, University of Montenegro, Faculty of Mechanical Engineering, 2016.
- [2] E. Tombarević, Modelling of phase change in heat storages with horizontal pipes, MSc thesis, University of Montenegro, Faculty of Mechanical Engineering, 2009. (in Montenegrin)

Other publications

- [1] N. Kažić, E. Tombarević, Handbook for the use of geothermal energy Montenegro, LEGEND project (Low Enthalpy Geothermal Energy Demonstration Cases for Energy), 2014. (in Montenegrin).
- [2] ENSI – Energy Savings International, N. Kažić, E. Tombarević, Energy efficiency in buildings: Methodology of energy audit and calculation of EE indicators, University of Montenegro, Faculty of Mechanical Engineering and Faculty of Architecture, 2011. (in Montenegrin) – support in translation from English.