

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Obnovljivi viri energije
Course title:	Renewable Energy Sources

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekotehnologije, 3. stopnja	/	1	1
Ecotechnologies, 3 rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: EKO3-881

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Peter Novak

Jeziki / Languages: slovenščina, angleščina
Slovenian, English

Vstopni pogoji:

Zaključena druga stopnja bolonjskega študija ali univerzitetni študijski program.

Prerequisites:

Completed Bologna B.Sc. or professional type of undergraduate education.

Vsebina:**Energija sonca**

Meteorološke osnove: sončno obsevanje, razporeditev, sezonske spremembe. Sekundarne oblike sončne energije: biomasa, padavine, veter, valovi. Pretvarjanje sončne energije v toploto: nizkotemperaturna konverzija (solarna arhitektura, gretje in hlajenje), visokotemperaturna konverzija (sončne elektrarne – SE), fotonapetostna konverzija (fizikalni in kemijski procesi, zgradba in karakteristike sončnih celic – PV, sestava v panele in PV sistemi). Uporaba biomase (toplotna konverzija, kemična konverzija, sintetična goriva). Elektrarne na vodo, veter, valove (teorija in konstrukcija). Izravnava nestacionarnosti OVE - shranjevanje energije. Energijska učinkovitost, stroški in ocena okoljskih vplivov. Bodoča vloga OVE v energetiki sveta.

Geotermalna energija

Pregled značilnosti geotermalnih sistemov – nizkotemperaturna in visokotemperaturna geotermalna polja. Pregled metod za geotermalne raziskave in izkoriščanje vrelcev. Uporaba

Contents:**Solar energy**

Meteorological background: solar irradiation, distribution and seasonal variation. Secondary form of solar energy: biomass, precipitations, wind, waves,. Solar thermal conversion: low temperature conversion (solar architectures, heating and cooling), high temperature conversion (power plants - CSP), photovoltaic conversion (physics and chemistry, design and characteristics of PV cells, PV panels design and systems). Biomass conversion (thermal, chemical, synthetic fuels). Hydro, wind and wave power plant (theory and design). Case studies from Europe and the U.S. Energy storage problems. Energy efficiency, costs and environmental impact assessments. Future role of renewable energy in the world energy supply.

Geothermal energy

A review of the main characteristics of geothermal systems - low-temperature and high-temperature geothermal fields. Overview of geothermal exploration and exploitation methodologies.

geotermalne energije (gretje in daljinsko gretje, toplotne črpalke, geotermalne elektrarne). Energijska učinkovitost, stroški in ocena okoljskih vplivov. Perspektiva uporabe geotermalne energije.

Shranjevanje energije in vodikova tehnologija

Osnovne tehnologije za shranjevanje energije. Občutena in latentna toplota, PCM, komprimiran zrak, baterije, kemični hranilniki (vodik, sintetična goriva). Značilnosti vodika. Elektroliza vode, napredni hidrolizerji. Varnost in vodik. Uporaba sončne in geotermalne energije za pridobivanje vodika. Shranjevanje vodika: a) komprimiranje plinastega vodika (CGH₂), utekočinjanje (LH₂), vodik kot surovina za metan (CH₄) in metanol (CH₃OH); b) kovinski hidridi, sestavljeni hidridi in druge kemične vezave. Ekonomija obstoječih tehnologij.

Geothermal resource utilization. Use of geothermal energy (heating and district heating, heat pumps, geothermal power plants). Energy efficiency, costs and environmental impact assessments. Prospects of geothermal energy use.

Energy Storage and Hydrogen Technology Basic technologies for energy storage. Sensible and latent heat, PCM, compressed air, batteries, chemical storages (hydrogen, syn-fuels). Hydrogen characteristics. Electrolysis of water; advanced electrolyzers. Hydrogen safety. Application of solar and geothermal energy for hydrogen production. Hydrogen storage: a) compressed gaseous hydrogen (CGH₂); liquid hydrogen (LH₂); hydrogen as raw materials for methane (CH₄) and methanol (CH₃OH); b) metal hydrides, complex hydrides and chemical bound storage. Economics of existing technologies.

Temeljna literatura in viri / Basic literature and sources:

- John Twidell, Tony Weir: RENEWABLE ENERGY RESOURCES, Third Edition, Routledge, TaylorFrancis Group, 2015, New York,
- A. V. da Rosa: FUNDAMENTALS OF RENEWABLE ENERGY PROCESSES, Third Edition, 2013, Academic Press Elsevier, Oxford, UK,
- Henrik Lund: RENEWABLE ENERGY SYSTEM, 2nd Edition, 2014, Academic Press Elsevier, Oxford, UK,
- Bent Soerensen: RENEWABLE ENERGY, Fourth Edition, 2011, Elsevier Ltd., Burlington, MA, USA,
- D.Y.Goswami, F. Kreith, J.F. Kreider: PRICIPLES OF SOLAR ENGINEERING, 2nd Edition, 2000, Taylor Francis, New York,
- R. Gassch, J. Twele: WIND POWER PLANTS, 2002, Solarpraxis AG, Berlin,
- S. Medved, P. Novak: VARSTVO OKOLJA IN OBNOVLJIVI VIRI ENERGIJE, 2000, UL-FS, Ljubljana.

Cilji in kompetence:

Osnovno razumevanje procesov pri konverziji in uporabi obnovljivih virov energije. Sposobnost izbora in uporabe tehnologij za konverzijo OVE.

Objectives and competences:

Basic understanding of processes by conversion and use of renewable energy. Skills for selection and application of RE conversion technologies.

Predvideni učni izidi

Znanje in razumevanje:

- Znanje pretvarjanja OVE
- Integracija tehnologij

Uporaba:

- Presoja uporabnosti tehnologij
- Ocenjevanje dolgoročnih vplivov tehnologij na okolje
- Načrtovanje sistemov za konverzijo OVE

Refleksija:

- Napovedovanje trendov

Prenosljive spretnosti:

- Interdisciplinarno znanje
- Združevanje (tehnologij, rešitev)

Intended learning outcomes:

Knowledge and Understanding

- Knowledge for RE conversion
- Technologies integration

Application:

- Assessment of Technologies Applicability
- Evaluation of Long-term Environmental Impact
- RE conversion system design

Reflection

- Trends Projections

Transferable skills

- Interdisciplinary Knowledge
- Integration (technologies, solutions)

Metode poučevanja in učenja:

- predavanja
- seminar
- konzultacije
- samostojno delo

Learning and teaching methods:

- lectures
- seminar work
- consultations
- individual work

Načini preverjanja znanja:	Delež / Weight	Assessment:
<ul style="list-style-type: none"> • seminar • ustni izpit 	50 % 50 %	<ul style="list-style-type: none"> • seminar • oral exam

Izbrane reference nosilca / Selected references of the lecturer:

- Novak P.: 2015, Sustainable Energy System without GHG Emissions for Cities and Countries, Energy and Buildings, 98 27-33,
- Novak P.: 2017, Exergy as Measure for Sustainability of Energy System, Int. J. Earth Environ Sci., 2,
- Novak P.: 2017, Sustainable Transactive Renewable Energy System, KGH, Belgrade,
- Novak, Peter: 2007, Slovenia - Low carbon society, why not? Presentation to the Member of the Globe, Slovenia and Slovenian Section Club of Rome,
- Novak Peter, 2007; Big sun – Solar electricity for North Africa, CD, International Congress Nicosia, Cyprus (Turkish).