

# OKOLJSKO INŽENIRSTVO

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Okoljsko inženirstvo
<b>Course title:</b>	ENVIRONMENTAL ENGINEERING
<b>Članica nosilka/UL Member:</b>	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - razvojno raziskovalni program, prva stopnja, univerzitetni (od študijskega leta 2024/2025 dalje)	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

<b>Univerzitetna koda predmeta/University course code:</b>	0562780
<b>Koda učne enote na članici/UL Member course code:</b>	2042-U

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		15			55	4

<b>Nosilec predmeta/Lecturer:</b>	Iztok Golobič, Primož Poredoš, Sašo Medved
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<b>Izvajalci predavanj:</b>	
<b>Izvajalci seminarjev:</b>	
<b>Izvajalci vaj:</b>	
<b>Izvajalci kliničnih vaj:</b>	
<b>Izvajalci drugih oblik:</b>	
<b>Izvajalci praktičnega usposabljanja:</b>	

<b>Vrsta predmeta/Course type:</b>	Splošni izbirni predmet /Elective general course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Izpolnjevanje pogojev za vpis v Univerzitetni študijski program I. stopnje Strojništvo - Razvojno raziskovalni program.

**Prerequisites:**

Meeting the enrollment conditions for the Academic study programme of Mechanical Engineering - Research and Development program.

**Vsebina:**

Uvod v okoljsko inženirstvo:

- Kronološki pregled razvoja okoljskega inženirstva;
- Mednarodne in Evropske okoljske politike, od priporočil Rimskega kluba do COP 25, IPCC.

2. Stanje okolja, kazalniki stanja okolja, trendi in cilji:

- stanje okolja, kazalniki stanja okolja,
- kakovost okolja, trendi in cilji.

3. Uredbe in predpisi, ki urejajo področje varovanja okolja v Sloveniji:

- Cilji in načela varstva okolja;
- Ustava, zakonodaja in direktive na področju varovanja okolja, Zakon o varstvu okolja, obveze države, lokalnih skupnosti, gospodarskih družb in posameznikov.

4. Okolje, prehrana, zdravje in inženirstvo:

- Okolje in prehrana, okolje in zdravje;
- Okoljski zdravstveni izzivi in inženirstvo.

5. Stavbe za zdravo bivanje:

- Zdravstveni izivi v notranjem okolju;
- Nič emisijske stavbe, preizkušanje in označevanje nizko in nič emisijskih snovi, stavbne instalacije za zdravo bivanje v notranjem okolju.

6. Potenciali in perspektive obnovljivih virov energije za brezogljične družbe:

**Content (Syllabus outline):**

Introduction to environmental engineering:

- Chronological overview of environmental engineering development;
- International and European environmental policy, from Club of Rome's recommendations to COP 25 and IPCC.

2. State of the environment, environmental indicators, trends and goals:

- State of the environment, environmental indicators;
- Quality of the environment, trends and goals.

3. Legislation and regulations on environmental protection in Slovenia:

- Goals and principles of environmental protection;
- Constitution, laws and directives enforcing environmental protection, Environmental protection act, obligations of the government, local communities, companies in individuals.

4. Environment, food, health and engineering:

- Environment and food supply, environment and health risks;
- Environmental health challenges and engineering.

5. Buildings for healthy living:

<ul style="list-style-type: none"> <li>- Obnovljivi viri energije, njihova vloga skozi zgodovino, v sedanjosti in prihodnosti;</li> <li>- Okoljski vplivi tehnologij obnovljivih virov energije.</li> </ul> <p>7. Tehnologije za energijsko samooskrbo na stavbah:</p> <ul style="list-style-type: none"> <li>- Stavbe ter neposredni in posredni vplivi na okolje;</li> <li>- Sodobne tehnologije za proizvodnjo toplote, hladu in električne energije na stavbah in njihova energijska učinkovitost.</li> </ul> <p>8. Onesnaževanje in onesnaženost vode:</p> <ul style="list-style-type: none"> <li>- Stanje hidrosfere, regulativa in zakonodaja na področju vode, vodni odtis;</li> <li>- Priprava in oskrba s pitno vodo, razsoljevanje morske vode.</li> </ul> <p>9. Čiščenje kapljevityh emisij:</p> <ul style="list-style-type: none"> <li>- Postopki čiščenja odpadne vode;</li> <li>- Čiščenje kapljevityh industrijskih emisij.</li> </ul> <p>10. Čiščenje plinskih emisij:</p> <ul style="list-style-type: none"> <li>- Postopki čiščenje zraka;</li> <li>- Čiščenje industrijskih plinskih emisij, membrane, zeoliti.</li> </ul> <p>11. Ravnanje s trdnimi odpadki:</p> <ul style="list-style-type: none"> <li>- Strategija ravnanja s trdnimi odpadki;</li> <li>- Upravljanje procesnih sistemov s trdnimi odpadki.</li> </ul> <p>12. Pregled tehnologij zbiranja in shranjevanja ogljika:</p> <ul style="list-style-type: none"> <li>- Okoljske politike in tehnologije zbiranja in shranjevanja ogljika;</li> <li>- Pregled osnovnih tehnologij zbiranja in shranjevanja ogljika.</li> </ul> <p>13. Okoljska etika in ekonomika okoljevarstva:</p> <ul style="list-style-type: none"> <li>- Metode ekonomske presoje okoljevarstvenih investicij;</li> <li>- Socialni stroški okoljskih škod, temeljna načela okoljske etike, etični kodeks inženirjev.</li> </ul> <p>14. Modeliranje emisij in imisij okoljskih procesov:</p> <ul style="list-style-type: none"> <li>- Modeliranje širjenja onesnažil v zraku iz točkovnih in linijskih virov, modeliranje onesnažil v vodotokih,</li> </ul>	<ul style="list-style-type: none"> <li>- Health challenges in indoor environment;</li> <li>- Zero emission buildings, self and labelling low and zero emission materials, building installations for healthy living in the indoor environment.</li> </ul> <p>6. Potentials and perspectives of renewable energy sources for carbonless societies:</p> <ul style="list-style-type: none"> <li>- Renewable energy sources, their role throughout the history, in the present time and in the future;</li> <li>- Environmental impact of renewable energy technologies.</li> </ul> <p>7. Technologies for energy self-sufficiency in buildings:</p> <ul style="list-style-type: none"> <li>- Direct and indirect effects of buildings on the environment;</li> <li>- Modern technologies for generation of heat, cold and electricity in buildings and their energy efficiency.</li> </ul> <p>8. Pollution and water pollution:</p> <ul style="list-style-type: none"> <li>- State of the hydrosphere, regulations and laws regarding water, water footprint;</li> <li>- Preparing and distributing drinking water, desalination of salt water.</li> </ul> <p>9. Cleaning liquid emissions:</p> <ul style="list-style-type: none"> <li>- Wastewater treatment processes;</li> <li>- Industrial liquid waste processing.</li> </ul> <p>10. Cleaning gaseous emissions:</p> <ul style="list-style-type: none"> <li>- Air purification processes;</li> <li>- Industrial gaseous waste processing, membranes, zeolites.</li> </ul> <p>11. Solid waste management:</p> <ul style="list-style-type: none"> <li>- Solid waste management strategy;</li> <li>- Managing process systems with solid waste.</li> </ul> <p>12. Overview of carbon capture and storage technologies:</p> <ul style="list-style-type: none"> <li>- Environmental policies and carbon capture and storage technologies;</li> <li>- Overview of basic carbon capture and storage technologies.</li> </ul> <p>13. Environmental ethics and economy of environmentalism:</p> <ul style="list-style-type: none"> <li>- Social costs of environmental pollution, fundamentals of environmental ethics, code of engineering ethics;</li> <li>- Methods for economic evaluation of</li> </ul>
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<p>naravnih vodnih rezervoarjih in podtalnici;</p> <ul style="list-style-type: none"> <li>- Metode in tehnike ukrepanja ob okoljskih nesrečah.</li> </ul> <p>15. Komunikacijske tehnike v okoljevarstvu:</p> <ul style="list-style-type: none"> <li>- Tehnike komuniciranja z javnostjo;</li> <li>- Mediacija v okoljevarstvu.</li> </ul>	<p>environmental investments.</p> <p>14. Modelling emissions and imissions of pollutants:</p> <ul style="list-style-type: none"> <li>- Modelling the spreading of pollutants from point and line sources, modelling of pollutants dispersion in water courses, natural reservoirs and groundwater;</li> <li>- Methods and techniques of emergency response in environmental disasters.</li> </ul> <p>15. Communicating in environmental protection:</p> <ul style="list-style-type: none"> <li>- Techniques of environmental public relations;</li> <li>- Mediation in environmental protection.</li> </ul>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Mulligan, Catherine N. Sustainable engineering: principles and implementation. Routledge, Taylor &amp; Francis, 2020 [COBISS.SI-ID <a href="#">67715075</a>]</li> <li>2. Atkins, Peter William, idr. Atkins' physical chemistry. 11th ed., Oxford University Press, 2018. [COBISS.SI-ID <a href="#">21197846</a>]</li> <li>3. Environmental and natural resources engineering. Let. 19, Springer, 2021, str. XVI, 512, doi:10.1007/978-3-030-54626-7_1. [COBISS.SI-ID <a href="#">115233539</a>]</li> <li>4. S. Medved, P. Novak, Varstvo okolja in obnovljivi viri energije, UL, Fakulteta za strojništvo, 2000. [COBISS.SI-ID <a href="#">105920256</a>]</li> <li>5. Masters GM. Introduction to environmental engineering and science. Englewood Cliffs, N.J.: Prentice-Hall; 1991. XVI, 460. [COBISS.SI-ID <a href="#">230939</a>]</li> </ol>
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### Cilji in kompetence:

Cilji:	Objectives and competences:
<p>Cilji:</p> <ol style="list-style-type: none"> <li>1. Spoznati osnove okoljevarstva, okoljskega inženirstva in trajnostnega razvoja.</li> <li>2. Spoznati problematiko okoljskega inženirstva in pristope pri njihovem reševanju.</li> <li>3. Spoznati osnovna in napredna orodja za razvojno raziskovalno inženirsko reševanje problematike okoljskega inženirstva. Utrjevati inženirski pristop varovanja okolja, načrtovanja trajnostnega razvoja in strategij ravnanja z odpadnimi snovmi ter prehoda v brezogljično družbo.</li> <li>4. Razvijati kreativnost in profesionalno inženirsko rast, timsko delo in interdisciplinarno povezovanje na</li> </ol>	<p>Objectives:</p> <ol style="list-style-type: none"> <li>1. Educate the student on the fundamentals of environmental protection, environmental engineering and sustainable development.</li> <li>2. Increase the student's awareness of problems in environmental engineering and present possible approaches to solving them.</li> <li>3. Educate the student on basic and advanced tools for research-and-development-oriented solving of problems in environmental engineering. Consolidate the use of an engineering approach in environmental protection, modelling of environmental pollution,</li> </ol>

<p>področju strojništva in trajnostnega razvoja.</p> <p>Kompetence:</p> <ol style="list-style-type: none"> <li>1. Sposobnost za opredelitev, razumevanje in ustvarjalno reševanje strokovnih izzivov na področju okoljskega inženirstva. Razvijanje profesionalne odgovornosti in etičnosti, spoštovanje inženirskega kodeksa in obvladovanje temeljnih teoretičnih znanj okoljskega inženirstva, ki so bistvena za obvladovanje tehničnega področja strojništva (S1-RRP, S9-RRP, P1-RRP).</li> <li>2. Upoštevanje varnostnih, funkcionalnih, gospodarskih in okoljevarstvenih načel pri inženirskem delu in sposobnost samostojnega pridobivanja novih znanj in veščin na področju okoljevarstva in trajnostnega razvoja. (S9-RRP, P5-RRP)</li> <li>3. Usposobljenost za delo v skupini in interdisciplinarno povezovanje ter sposobnost kreativnega reševanja posameznih dobro definiranih nalog varovanja okolja in trajnostnega razvoja na področju strojništva. (S8-RRP, P6-RRP)</li> </ol>	<p>development of strategies for waste management and planning of the transition into a carbonless society.</p> <ol style="list-style-type: none"> <li>4. Develop creativity and professional growth as an engineer, develop team work and interdisciplinary connections within engineering and sustainable development.</li> </ol> <p>Competences:</p> <ol style="list-style-type: none"> <li>1. The ability to define, understand and creatively solve professional challenges in environmental engineering. Development of professional responsibility and ethical behaviour, mastery of basic theoretic skills, fundamental to the technical aspect of environmental engineering. (S1-RRP, S9-RRP, P1-RRP)</li> <li>2. Following safety, functional, economic and environmental principles in their work and the ability to acquire new knowledge and skills in environmental engineering and sustainable development independently. (S9-RRP, P5-RRP)</li> <li>3. The ability to work in teams and interdisciplinary including the ability to creatively solve individual well-defined engineering tasks in the field of environmental engineering and sustainable development. (S8-RRP, P6-RRP)</li> </ol>
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### **Predvideni študijski rezultati:**

<p>Znanje:</p> <p>Poglobljeno strokovno teoretično in praktično znanje na področju okoljskega inženirstva in trajnostnega razvoja podprto s široko teoretično in metodološko osnovo in dodanimi praktičnimi primeri. (Z1)</p> <p>Spretnosti:</p> <ol style="list-style-type: none"> <li>1. Izvajanje kompleksnih analiz stanja okolja, okoljevarstva in trajnostnega razvoja, ki vključujejo tudi uporabo metodoloških orodij. (S1)</li> <li>2. Obvladovanje zahtevnih, kompleksnih</li> </ol>
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### **Intended learning outcomes:**

<p>Knowledge:</p> <p>Thorough professional theoretical and practical knowledge in the field of environmental engineering and sustainable development that is supported with a broad theoretical and methodological basis and added practical examples. (Z1)</p> <p>Skills:</p> <ol style="list-style-type: none"> <li>1. Executing complex analyses of the state of environment, environmental protection and sustainable development, which incorporates</li> </ol>
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<p>in interdisciplinarnih procesov okoljskega inženirstva ob samostojni uporabi znanja pri reševanju novih trajnostnih izzivov okoljskega inženirstva. (S1.2)</p> <p>3. Diagnosticiranje in reševanje problemov okoljskega inženirstva na področju okolja in trajnostnega razvoja s poudarkom na plinastih, kapljevutih in trdnih emisijah, kakovosti vode in zraka, zdravega in energijsko samozadostnega bivanja v stavbah in problematike prehoda v brezogljično družbo. (S1.3)</p>	<p>usage of methodological tools. (S1)</p> <p>2. Mastering demanding, complex and interdisciplinary work processes of environmental engineering by independent usage of obtained knowledge in solving new sustainability challenges of environmental engineering. (S1.2)</p> <p>3. Problem diagnostics and solving in environmental engineering in the fields of environment and sustainable development with an emphasis on gaseous, liquid and solid emission, water and air quality, healthy and energy self-sufficient living in buildings and problems of transition into a carbonless society. (S1.3)</p>
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#### **Metode poučevanja in učenja:**

#### **Learning and teaching methods:**

<p>P1 Avditorna predavanja z reševanjem izbranih teoretičnih in praktično uporabnih primerov okoljskega inženirstva.</p> <p>P3 Avditorne vaje, kjer se teoretično znanje iz predavanj podkrepi z računskimi primeri obravnavanih področij okoljskega inženirstva.</p> <p>P8 Izdelava in predstavitev aplikativnih seminarskih nalog iz področja okoljskega inženirstva.</p> <p>P9 Timsko razvojno raziskovalno projektno delo na konkretni problematiki okoljevarstva s predstavitvijo in razpravo</p> <p>P12 Individualizirane domače naloge v spletni učilnici.</p> <p>P15 Uporaba video vsebin okoljskega inženirstva, trajnostnega razvoja in prehoda v brezogljično družbo.</p>	<p>P1 Auditorial lectures with solving selected theoretical and applied use cases in the field of environmental engineering.</p> <p>P3 Auditorial exercises, in which theoretical content from the lectures is supplemented with practical examples of environmental engineering problems.</p> <p>P8 Making and presenting applied seminar exercises in the field of environmental engineering.</p> <p>P9 Team research and development work based on presented problems of environmental engineering including presentation and discussion.</p> <p>P12 Individualised homework in a web classroom.</p> <p>P15 Application of videos related to environmental engineering, sustainable development and transition into a carbonless society.</p>
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#### **Načini ocenjevanja:**

#### **Delež/ Weight**

#### **Assessment:**

Teoretična vsebine (predavanja, računske naloge).	60,00 %	Theoretical content (lectures, calculation problems).
Samostojno/skupinsko delo na	20,00 %	Individual/group work during

vajah.		auditorial exercises.
Seminar.	20,00 %	Seminar.

### Ocenjevalna lestvica:

### Grading system:

5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10
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### Reference nosilca/Lecturer's references:

#### Iztok Golobič:

1. SERIANZ, Luka, RMAN, Nina, **GOLOBIČ, Iztok**, BRENČIČ, Mihael. Groundwater heat transfer and thermal outflow plume modelling in the Alps. Renewable energy. [Print ed.]. Jan. 2022, vol. 182, str. 751-763, ilustr. ISSN 0960-148 DOI: 10.1016/j.renene.2021.10.004. [COBISS.SI-ID [84190979](#)].
2. ŽALEC, Domen, HANAK, Dawid P., MOŽE, Matic, **GOLOBIČ, Iztok**. Process development and performance assessment of flexible calcium looping biomass gasification for production of renewable gas with adjustable composition. International journal of energy research. Apr. 2022, vol. 46, iss. 5, str. 6197-6215, ilustr. ISSN 0363-907X. DOI: 10.1002/er.7558. [COBISS.SI-ID [91355395](#)].
3. ZUPANČIČ, Matevž, MOŽIC, Valerija, MOŽE, Matic, CIMERMAN, Franc, **GOLOBIČ, Iztok**. Current status and review of waste-to-biogas conversion for selected european countries and worldwide. Sustainability. 2022, vol. 14, iss. 3, str. 1-25, ilustr. ISSN 2071-1050. DOI: 10.3390/su1403182 [COBISS.SI-ID [97006595](#)].
4. SIELAFF, Axel, MANGINI, D., KABOV, O., RAZA, Md. Qaisar, GARIVALIS, Alekos Ioannis, ZUPANČIČ, Matevž, **GOLOBIČ, Iztok**, et al. The multiscale boiling investigation on-board the International Space Station : an overview. Applied thermal engineering. [Print ed.]. Mar. 2022, vol. 205, str. 1-23, ilustr. ISSN 1359-4311. DOI: 10.1016/j.applthermaleng.2021.117932. [COBISS.SI-ID [93026307](#)].
5. **GOLOBIČ, Iztok**, BERCE, Jure, BUCCI, Mattia, GORRE, Jachin, HADŽIĆ, Armin, MOJŠKERC, Bor, MOŽE, Matic, SEDMAK, Ivan, ZUPANČIČ, Matevž, ŠTURM, Roman, ŽAGAR, Sebastjan. Študija vpliva obnovljivih plinov vključno z vodikom na materiale in elemente prenosnega plinovodnega sistema : zaključno poročilo. Ljubljana: Fakulteta za strojništvo, Laboratorij za toplotno tehniko, 2021. XVIII, 253 f., ilustr. [COBISS.SI-ID [89524739](#)].

#### Sašo Medved:

1. GALIČIČ, An, ROŽANEC, Jan, KUKEC, Andreja, CARLI, Tanja, **MEDVED, Sašo**, ERŽEN, Ivan. Identification of indoor air quality factors in Slovenian schools : national cross-sectional study. Processes. [Online ed.]. 2023, vol. 11, iss. 13, 16 str., ilustr. ISSN 2227-9717. <https://www.mdpi.com/2227-9717/11/3/841>, DOI: 10.3390/pr1103084 [COBISS.SI-ID [146393347](#)]; 01
2. **MEDVED, Sašo**, DOMJAN, Suzana, ARKAR, Ciril. Contribution of energy storage to the transition from net zero to zero energy buildings. Energy and buildings. [Print ed.]. Apr. 2021, vol. 236, str. 1-13, ilustr. ISSN 0378-7788. <https://www.sciencedirect.com/science/article/pii/S0378778821000359?via>

- %3Dihub, <https://repozitorij.uni-lj.si/IzpisGradiva.php?id=124722>, DOI: 10.1016/j.enbuild.2021.110751. [COBISS.SI-ID [51396355](#)]; 1.01
3. ŠUKLJE, Tomaž, HAMDY, Mohamed, ARKAR, Ciril, HENSEN, Jan, **MEDVED, Sašo**. An inverse modeling approach for the thermal response modeling of green façades. *Applied energy*. Feb. 2019, vol. 235, str. 1447-1456, ilustr. ISSN 0306-2619.  
<https://www.sciencedirect.com/science/article/pii/S0306261918317720?via%3Dihub>, <https://repozitorij.uni-lj.si/IzpisGradiva.php?id=105462>, DOI: 10.1016/j.apenergy.2018.11.066. [COBISS.SI-ID [16368155](#)]; 1.01
  4. DOMJAN, Suzana, ARKAR, Ciril, FINK, Rok, **MEDVED, Sašo**. Evaluation of energy efficiency of buildings based on LCA and LCC assessment – method, computer tool and case studies : chapter 7. V: BIENVENIDO-HUERTAS, David (ur.). *Nearly zero energy building (NZEB) : materials, design and new approaches*. London: IntechOpen, 2022. Str. 125-151, ilustr. ISBN 978-1-80355-312-2, ISBN 978-1-80355-314-6.  
<https://www.intechopen.com/chapters/80014%205>, DOI: 10.5772/intechopen.101820. [COBISS.SI-ID [116411395](#)]; 1.16
  5. **MEDVED, Sašo**, DOMJAN, Suzana, ARKAR, Ciril. Trajnostne tehnologije za skoraj nič-energijske stavbe : načrtovanje in presoja. Ljubljana: Fakulteta za strojništvo, Laboratorij za okoljske tehnologije v zgradbah, avg. 2017. V, 172 str., ilustr. [COBISS.SI-ID [16017435](#)]; 2.12

#### Primož Poredoš:

1. **POREDOŠ, Primož**, SHAN, He, WANG, Chenxi, DENG, Fangfang, WANG, Ruzhu. Sustainable water generation : grand challenges in continuous atmospheric water harvesting. *Energy & environmental science*. Aug. 2022, vol. 15, no. 8, str. 3223-3235, ilustr. ISSN 1754-5706.  
<https://pubs.rsc.org/en/content/articlelanding/2022/ee/d2ee01234k/unauth>, [Repozitorij Univerze v Ljubljani - RUL](#), DOI: [10.1039/D2EE01234K](#). [COBISS.SI-ID [143310083](#)]
2. SHAO, Zhao, WANG, Zhi-Shuo, LV, Haotian, TANG, Yu-Cheng, WANG, Hongbin, DU, Shuai, SUN, Ruikun, FENG, Xi, **POREDOŠ, Primož**, et al. Modular all-day continuous thermal-driven atmospheric water harvester with rotating adsorption strategy. *Applied physics reviews*. Dec. 2023, vol. 10, iss. 4, [article no.] 041409, str. 1-11, ilustr. ISSN 1931-9401.  
<https://pubs.aip.org/aip/apr/article-abstract/10/4/041409/2921320/>, [Repozitorij Univerze v Ljubljani - RUL](#), DOI: [10.1063/5.0164055](#). [COBISS.SI-ID [185953539](#)]
3. SHAN, He, LI, Chunfeng, CHEN, Zhihui, YING, Wenjun, **POREDOŠ, Primož**, YE, Zhanyu, PAN, Quanwen, WANG, Jiayun, WANG, Ruzhu. Exceptional water production yield enabled by batch-processed portable water harvester in semi-arid climate. *Nature communications*. 2022, vol. 13, article no. 5406, str. 1-10, ilustr. ISSN 2041-1723. <https://www.nature.com/articles/s41467-022-33062-w>, [Repozitorij Univerze v Ljubljani - RUL](#), DOI: [10.1038/s41467-022-33062-w](#). [COBISS.SI-ID [143312899](#)]
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