Klaipėda University strategic research directions

"Towards sustainable technologies, blue and green growth and a healthy sea"

Postdoctoral Fellowship Topic Application (2023-2025)

Title	Development of a novel integrated solar PV powered system for Green Hydrogen production from wastewater
Research field(s) of the traineeship, host department, start date, duration	Photo energy, fuel cell, Electrical and Electronic Engineering, Technological sciences, Chemical engineering. The traineeship would take place in the Department of Engineering. Start from 1st of September of 2023 until 31st of December of 2023. Duration two years.
Brief description of the research and the results to be obtained (aim and objectives, keywords)	Hydrogen is a secondary renewable energy source. There are three main types of hydrogen: gray, blue, and green. Gray hydrogen are produced from fossil fuel and blue hydrogen is produced from natural gas. Fossil fuel and natural gas has very high internal energy densities, but the main problem is greenhouse gas (especially CO2) emissions and other particulate matter. Alternative energies, such as renewable energy, are available, and green hydrogen comes from renewable energy. In this study, a solar PV power-based piezoelectric transducer with nanobubbles for wastewater-splitting photocatalysis for hydrogen production and storage is proposed. Piezoelectric transducer wastewater-splitting is a new system and could be highly efficient in producing green hydrogen for sustainable development. This system is self-sufficient to filter wastewater and is connected to solar PV energy, so there is no external power supply needed. The whole system is based on renewable energy and can be planted anywhere. Solar PV and green hydrogen are both active energies. Therefore, both energy sources are directly utilized in the residential and transportation sectors. The aim of the project is to research and develop a technology for wastewater processing for the purpose of green hydrogen production along with storage systems development. A novel solar powered reactor system will be designed, installed and commissioned with the facilities to conduct photocatalytic reactions and nanobubble generation. Specific objectives: 1. To propose a physical model for photocatalytic treatment of wastewater by incorporating specific piezoelectric transducers adaptable to be powered by a solar PV source. 2. To characterize the of wastewater and determine the composition of compounds with hydrogen after photocatalytic treatment. 3. To conduct series of experiments on hydrogen production at laboratory-scale by maintaining real-time conditions using photocatalysis with a piezoelectric transducer.

	4. To determine the optimum process conditions considering energy consumption, specific control parameters like; frequency, amplitude, transmitted power, rate of hydrogen production etc. Additionally, the computation of interactions between/among the controlling process parameters on the hydrogen yield/kWh will be determined. 5. To propose and develop a method for storing green hydrogen, and to test the efficiency of the storage method - whether and if there is any diffusion of hydrogen from the storage device. Keywords: Solar PV energy, piezoelectric transducer, wastewater-splitting, photocatalysis system, hydrogen production, hydrogen storage.
Relevance of the topic to the objectives and priorities of the strategic research thrust	The proposed topic corresponds to the strategic scientific direction of Klaipėda University "Towards sustainable technologies, blue and green growth and a healthy sea" (Senate Resolution of 06/18/2020, No. 11-70) of the objective "Improving the quality of the marine environment and development of future technologies" priority "Resource-saving, circular technologies based on economic principles". The topic will contribute to the creation of new and sustainable energy-efficient equipment or system for the production of green hydrogen by PV systems from wastewater thus including circular economy aspects.
Planned intermediate and final results (scientific outputs: publications, reports, etc.)	2 scientific publications with the quality of CA WOS with quartile of Q1 or Q2 will be produced and a conference will be attended. One final report will be prepared. One working system prototype of Solar PV-powered green hydrogen production from wastewater created.
Requirements for the trainee	A Ph.D., preferably in the natural sciences or technology. Preferably, the candidate should be able or willing to work in a laboratory and have experience in electrical engineering or other research. It would be an advantage if the candidate has mastered modern analytical methods and has experience in evaluating and interpreting data using statistical analysis methods. The candidate should be able to summarize results in reports and present them both internally and at conferences. Experience in preparing manuscripts is required. Strong communication skills, a systematic working style, reliability, commitment and team spirit are desirable. Good oral and written English language skills are required.
Subject endowment (infrastructure, link to ongoing projects)	The need for equipment will be necessary for the production of a prototype of the planned topic. Equipment – PV stand, signal generator, PC, current sensor, high frequency power amplifier, piezoelectric transducer, hydrogen sensors, data logger, power meter, current probe, tanks, materials for hydrogen storage design, temperature sensors, wastewater analysis equipment. The main

	scientific work will be carried out in the laboratories Engineering department of the Faculty of Marine Technology and Natural Sciences – PV stand (114 lab.), PC, oscilloscope (422 lab.), signal generator (422 lab), power meter (413 lab.), current sensor (413 lab.), temperature sensors (422 lab.) and the Laboratory of Mechanics and Marine Engineering of Marine Research Institute – oscilloscope, PC, data logger, hydrogen storage design and construction services. Needed equipment to buy - high frequency power amplifier, hydrogen sensors, high frequency current probes, tanks, piezoelectric transducer, materials for hydrogen storage design and construction.
Intended supervisor of the traineeship	Dr. Audrius Senulis (audrius.senulis@ku.lt) tel.: +370-614-83468 Consultants Assoc. prof. dr. Žilvinas Kryževičius (zilvina.kryzevicius@ku.lt), tel.: +370-684+34462), dr. Khan Mohammad Jakir Hossain (khan.mohammad-jakir-hossain@ku.lt) tel.: +370-696-03676 Assoc. prof. Artūras Tadžijevas (arturas.tadzijevas@ku.lt), tel.: +370-655-38841
Manager's work on the proposed topic	Dr. Audrius Senulis has experience in academic leadership, research projects and development of new technologies. Consultants have experience in chemical engineering and technology. Supervisor and consultants with multidisciplinary experience in solar and wind powered vehicles, technology development, chemical engineering systems research: 1. Scientific work in developing fully electric city bus “Dancer”, work area – bus electrical system design, energy storage system development. (Since 2012, www.dancerbus.com) 2. Working in the project “The autonomous green port of the future: development of a new method and system prototype for container handling” funded by Lithuanians Scientific Council. The work are was energy flow and control analysis. (https://2014.esinvesticijos.lt/lt/paraiskos_ir_projektai/ateities-autonominis-zaliasis-uostas-naujo-konteineriu-krovos-metodo-ir-sistemos-prototipo-sukurimas) 3. Drungilas, D., Kurmis, M., Senulis, A., Lukošius, Ž., Andziulis, A., Janutėnienė, J., Bogdevičius, M., Jankūnas, V., & Voznak, M. (2023). Deep reinforcement learning based optimization of automated guided vehicle time and energy consumption in a container terminal (null67). Amsterdam : Elsevier. https://doi.org/10.1016/j.aej.2022.12.057 4. Eglynas, T., Jusis, M., Jakovlev, S., Senulis, A., Andziulis, A., & Gudas, S. (2019). Analysis of the efficiency of shipping containers handling/loading control methods and procedures. https://doi.org/10.1177/1687814018821229 5. Karpavičius, A., Senulis, A., Determining the energy capacity requirement of the electric passenger ferry for the Curonian

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