19th CONFERENCE ON SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

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INTERNATIONAL CENTRE FOR SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

BOOK OF ABSTRACTS

www.rome2024.sdewes.org

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September 8-12, 2024, Rome, Italy

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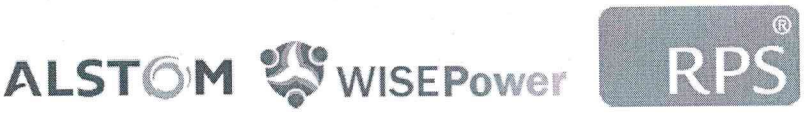

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Publisher Faculty of Mechanical Engineering and Naval Architecture, Zagreb

ISSN 2706-3690 (digital proceedings)

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Conference Venue: Rome, Italy

Rome is the capital of the Italian Republic and the most populous and largest municipality in Italy and is among Europe's major capitals in terms of the amount of terrain it covers.

As All roads lead to Rome, we hope to see you all at Sdewes conference In Rome. The proverb comes from the efficient road system of ancient Rome, on which much of the current Italian road system is based. Many roads started from Rome and, if taken in the opposite direction, "led to Rome.".

It is the city with the highest concentration of historical and architectural riches in the world. Its historical centre, outlined by the enclosing Aurelian Walls, layering nearly three thousand years of antiquity, is an invaluable testimony to the European western world's cultural, artistic and historical legacy and in 1980 it was, together with the Holy See's property beyond the confines of the Vatican State as well as the Basilica of St. Paul outside the Walls, were added to UNESCO's World Heritage List .

Rome, the heart of Catholic Christianity, is the only city in the world to host an entire foreign state within its confines, the enclave of the Vatican City, and it is for this very reason that it is often referred to as the capital of two States. Over 16% of the world's cultural treasures are located in Rome (70% in all of Italy).

Over the centuries, the magic of Rome has been masterly told by poets and writers and wonderfully depicted in the works of great artists. Eternal and mysterious, the Capital envelops those who arrive in a pleasant "sickness of Rome" that does not abandon. It is no coincidence that millions of tourists hurry to throw a coin into the Trevi Fountain

with the hope of returning to visit it: because in Rome, remembering Goethe's words, everything is as we imagined it, and everything is new.

If you don't know it yet, or if you want to return to immerse yourself in its charm, here, we try to briefly describe its profile, soul, and colours.

Scope and Objectives

The 19th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) is dedicated to the advancement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from the use of natural resources and by a transition to a knowledge-based economy. All taking into account the economic, environmental and social pillars of sustainable development.

One of the main issues of the coming decades is to improve efficiencies by integrating various life-supporting systems, using excess from one, as resource in another in the correct moment. Integrating electricity, heating, cooling, transport, water, buildings, waste, wastewater, industry, forestry and agriculture systems will be pivotal towards sustainable development.

Sustainability being also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the SDEWES Conference has become a significant venue for researchers in those areas to meet, and originate, discuss, share, and disseminate new ideas:

> "History teaches us that men and nations behave wisely once they have exhausted all other alternatives"
>
> *Abba Eban*

Sustainability methods and approaches

- Sustainability comparisons and measurements (metrics and indices; multi-criteria analysis; external costs; exergy analysis; footprint methods; life cycle analysis)
- Green economy and better governance (circular economy; low carbon development/economy; resource efficiency; water reuse; jobs and regional development; macroeconomic analysis; financial and regulatory mechanisms; models and tools; rebound effect; energy economics; environmental economics; development economics; sustainability economics)

Planning, management and analysis

- Smart energy systems (markets; demand response; integration of power, heating/cooling, transport, water and waste sectors; smart grids; dynamic electricity pricing; microgrids; digitalisation; blockchain; artificial intelligence; Internet of things; GIS; virtual net metering; community energy; energy cooperatives; gamification; transactive energy)
- Energy system analysis (energy planning; power system planning; smart energy systems; smart energy networks; power-gas integrated system planning; 100% renewable energy systems; high penetration of renewables; island energy systems; development of energy planning tools; internalizing environmental externalities;

electrification of transport; storage vs. grids vs. demand management; long term demand planning; integration of power and district heating systems; integration of power and water systems; integration of power and transport systems; power to gas; hydrogen valleys)
- Transport management (transport system analysis, dynamic road pricing; electrification of transport)
- Water-energy nexus (water management; water system analysis; water pricing; water desalination; hydro energy; water-renewables integration, water resources; river basin management; arid areas; climate change adaptation; water security; digitalisation; blockchain; artificial intelligence; Internet of things; GIS)
- Sustainable tourism (green hotels; certification)
- Urbanism (climate-neutral and smart cities; urban planning; zoning; transport; zero energy buildings/districts; sustainable energy action plans; district heating/cooling)
- Regional planning and cooperation (sustainable islands; regions and cities; 100% renewable regions)

Policy and system transitions

- Energy and climate policy (security of supply; climate change mitigation; energy transition; renewable energy support schemes; energy efficiency policy; employment creation; carbon pricing; markets; fossil fuel subsidies)
- Smart transport systems and policy (fuel/carbon economy; transport electrification; congestion and road pricing; multimodal management; alternative fuels; social aspects; autonomous mobility; railways; shipping; aviation)
- Energy markets (market/price coupling; liberalisation/deregulation; modelling; demand response; role of district heating; role of desalination and water pumping; storage; retail markets; grid parity; net metering; price caps; energy market design)
- Emission markets (emission trading system; cap and trade; transport participation; heating participation)
- Environmental policy and management (waste management; wastewater management; climate change mitigation; climate change adaptation; air pollution policy; water pollution policy; land management; biomass management; rewilding; social aspects; strategic environmental impact assessment, environment and corporate social responsibility, quality management systems; environment management systems; eco management and audit schemes; occupational health and safety assessment systems; hazard analysis and critical control point; integrated management systems)
- Agricultural policy (energy and water use in agriculture and food processing; food vs. biofuels; sustainability of biofuels production)
- Social acceptance (reform; NIMBY; nuclear; wind; biofuels; hydrogen; hidden and special interests; cost-based pricing; inclusion; fossil fuel subsidy; green economy and employment; gender issues; energy poverty; energy affordability)
- Sustainable resilience of systems (resilience of energy systems; resilience of water systems; resilience of environmental systems; resilience of agricultural systems; resilience of social systems; resilience of engineering systems)
- Research, innovation and development (industry-academia partnership; quadruple helix; knowledge-based society; knowledge management; learning curve; technology foresight; science diplomacy)

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."

Buckminster Fuller, philosopher, futurist and global thinker (1895 - 1983)

- Education in sustainable development (governance; environmental awareness; higher education; engineering education)

Resources and technologies

- Renewable energy resources (biomass; hydro; wind; solar; geothermal; wave and ocean; technical and economic potentials; barriers; cost and benefits; integration, adaptation)
- Primary energy resources (oil peaking; gas peaking; coal peaking; nuclear fuels)
- Renewable electricity conversion systems (biomass; hydro; wind; offshore wind; high altitude wind; photovoltaic; concentrated solar thermal power; geothermal; wave; tide; ocean thermal)
- Thermal power plants (combined cycles; advanced cycles; flexible operation and cycling; carbon capture and storage/sequestration/reuse; post-combustion: chemical absorption; oxyfuel combustion; nuclear)
- District heating and/or cooling (integration of renewable heat; cogeneration; industrial waste/excess heat; waste to energy; power to heat; electric boilers; large-scale heat pumps; wastewater heat pumps; sea water heat pumps; aquifer heat pumps; integration of CHP with district heating and electricity markets; heat maps; distribution; solar thermal district heating; geothermal district heating)
- Nano and micro technologies and science for sustainable development of energy, water, and environment systems
- Advanced sustainable energy conversion systems (fuel cells; thermoelectric; thermionic; organic; ORC; waste/excess heat recycling; thermoacoustic; piezoelectric; hybrid fuel cell-gas turbine system; molten carbonates fuel cell; solid oxide fuel cell; PEM fuel cell; thermo-acoustic heat pump; absorption heat pump; electrolyser)
- Renewable heat systems (biomass; biofuels; biogas; solar; geothermal)
- Biofuels and biorefineries (biodiesel; bioethanol; biogas; second and third generation biofuels; waste to biofuels; algae; anaerobic digestion; biomass to liquids; biorefineries; sustainable aviation fuel; infrastructure; sustainability assessment; pyrolysis; torrefaction; coproduction)

"If there are to be problems, may they come during my life-time so that I can resolve them and give my children the chance of a good life."

Kenyan proverb

- Alternative fuels (hydrogen; electro-fuels; power to gas; synthetic fuels; BTL: sustainable aviation fuels; DME; compressed methane; liquified methane; ammonia; methanol; resources; production; vehicles; infrastructure)
- Hybrid and electric vehicles (hybrid; plug in hybrid electric vehicle; battery electric vehicle; fuel cell electric vehicle; charging; batteries; infrastructure)
- Water treatment (drinking water; industrial water)
- Water desalination (distillation; reverse and forward osmosis; electrodialysis; energy recovery; discharge management; renewable and desalination coupling)
- Waste and wastewater treatment and reuse (avoiding waste; composting; recycling; resource recovery from wastewater; waste to energy; anaerobic digestion; gasification; mechanical biological treatment; mechanical heat treatment; plasma arc waste disposal; pyrolysis; RDF/SRF; combustion modelling)
- Cogeneration, trigeneration, polygeneration (heat/cold and power; water and power; biofuels and power; transport and energy; food and energy; applications and operation strategies)
- Storage (thermal energy storage; ice storage; phase change materials storage; aquifer thermal energy storage; borehole thermal energy storage; hydropower as storage;

pumped hydro storage; compressed air energy storage; liquid air energy storage; water storage; flywheel energy storage; salinity gradient; physical energy storage; batteries; redox flow; hydrogen storage; biofuels storage; chemical energy storage; storage optimisation modelling; financial support mechanisms; power market arbitrage; direct lithium extraction (brine))

- Electricity transmission and distribution (grid extension and robustness; long distance transmission; power quality; HVDC power transmission; meshed HVDC grid; dynamic line rating; flexible alternating current transmission systems (FACTS); virtual inertia-fast frequency response; grid forming inverters; power electronics)
- Gas security of supply (diversification; shale gas; extension of transmission pipelines; LNG; Southern Corridor)
- Hydrogen transport (pipelines; blending; liquified hydrogen ships; compressed hydrogen ships; ammonia; safety; skills)
- Energy and water decarbonisation and efficiency in industry and mining (cement and lime; construction materials; glass; pulp and paper; food industry; metallurgy; chemical industry; process optimisation; kilns; boilers; heat exchange networks; pinch analysis; exergy and exergoeconomic analysis; energy audits; water use and waste minimisation; eco-innovation; total site integration; life cycle assessment; eco-design and eco-labelling; product cycle assessment; cleaner production, environmental impact assessment; hydrogen in industry)
- Energy efficient appliances (smart appliances; labelling and standards; user behaviour)
- Lighting (lamps and luminaires; organic LED; conventional LED; advanced lighting control system, direct current lighting)
- Cooking (electric stove; induction cooking; improved biomass cooking stove; solar cooking; domestic biogas digester; bag digester; composite material digester)
- Buildings (nearly zero energy buildings; passive buildings; smart buildings; smart metering; ICT; load and demand side management; green buildings; building codes and standards; buildings certification; HVAC; insulation; renewables integration; district heating; heat pumps; storage; sustainable architecture; buildings construction and renovation; material efficiency; lightweighting; thin shelled concrete; fabric formwork; composite construction; composite materials; additive manufacturing; prefabrication; building orientation; natural ventilation; dual flow ventilation; insulation glass coating; dynamic glazing; thermochromic fenestration; electrochromic fenestration; high reflectivity paint; radiative reflective roof, Trombe wall; structural insulated panel, aerogel insulation; building integrated heat and moisture exchange panel; vacuum insulated panel; dynamic building envelope; transpired solar heat collectors; double skin façade; vapor permeable walls; air sealing; building integrated phase change materials; building integrated solar thermal collector)

Cross-cutting aspects for sustainability

- Climate change modelling and analysis (climate change scenarios; narratives of climate change; integrated assessment models (IAM))
- Modelling for pollution avoidance and energy efficiency (CFD models; air pollution spreading; water pollution spreading; heat and mass transfer modelling; combustion modelling)
- Political aspects of sustainable development (long term planning; Sustainable Development Goals; the role of political leaders and of voters; international conflict vs. sustainable development; security and sustainability; resource and political security)

Preface

The objective of the series of conferences on Sustainable Development of Energy, Water and Environment Systems (SDEWES) is to provide a forum for world-wide specialists and those interested in learning about the sustainability of development, to present research progress and to discuss the state of the art, the future directions and priorities in the various areas of sustainable development. This includes the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding climate, energy, transport, agriculture, water and environment systems and their many combinations. The reason for the forum having such a wide scope is due to the need for holistic integrated solutions encompassing several or all.

Prof. Henrik Lund

Chair of the International Scientific Committee

Prof. Davide Astiaso Garcia

Chair of the Local Organising Committee

Prof. Neven Duić

SDEWES Centre President

Prof. Zvonimir Guzović

Conference Secretary

BOOK OF ABSTRACTS

SDEWES2024.1082

Pinewood Pyrochar-Based Green Catalyst as Powerful Persulfate Activation Tool for the Removal of Contaminants of Emerging Concern from Wastewater

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Abstract

Contaminants of emerging concern (CECs) are very tenacious water pollutants, and due to their suspect or proven toxicity, persistence, and bio-accumulation, represent a significant threat to human and ecosystem safety. These compounds, ranging from pharmaceutical active substances to industrial chemicals, are not the subject of routine monitoring or emission control. The concentration of CECs in environmental samples is commonly at a very low level, indicating that traditional water treatment methods may be inadequate for their effective removal. Sulfate radical based advanced oxidation processes using heterogeneous catalysts have recently received significant attention as a viable technology for the removal of CECs. Since waste reutilization is always highly desired in the environmental engineering, biomass waste represents an excellent precursor for the production of carbon material – biochar (pyrochar and hydrochar), serving as the main component for the development of green catalysts for persulfate activation.

The aim of this study was to develop a facile one-pot green strategy for the synthesis of metal-free (heteroatom doped) pyrochar-based catalysts as efficient persulfate activators for the degradation of selected CECs belonging to pharmaceutically active compounds and pesticides. Due to comparison, a series of iron-based heteroatom doped catalyst samples was prepared using the same preparation procedure. The pinewood sawdust, as highly abundant biowaste material in Serbia, was used as carbon precursor. The catalytic abilities of the synthesized samples were tested on a water solution model mixture of 22 CECs (10 μg/l concentration of each compound). Metal-free pyrochar-based catalysts exhibited significantly higher activity compared to their Fe-based counterparts. The single doped ones showed excellent catalytic performance in relation to the co-doped ones, achieving 100% removal of 17 CECs within the first 30 min of the reaction. It is expected that this work provides new insights into the rational design of pyrochar-based catalysts for persulfate activation in practical applications of CECs-related pollution control.

Acknowledgements: Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or EU executive agency. Neither the European Union nor the granting authority can be held responsible for them. This study is conducted under the project TwiNSol-CECs that has received funding from Horizon Europe programme under grant agreement no.101059867.