15th CONFERENCE ON SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

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BOOK OF ABSTRACTS

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Conference Venue: Cologne

Cologne, the 2000-year-old city on the Rhine, is famous for its cathedral and Romanesque churches, its museums and galleries, its vitality, the carnival, and the Kölsch pubs. Cologne is one of the oldest large German cities and its name dates back to Roman times. The Romans founded the Ubii village on the Rhine in 50 AD and named it "Colonia". In the Middle Ages, Cologne was the most densely populated and one of the most prosperous towns in the German-speaking region - in particular due to the pilgrims and trade benefits that the newly introduced 'staple right' brought. With the Industrial Revolution and the incorporation of large parts of the surrounding area, Cologne became an industrial city.

During the Second World War around 90 percent of the inner city was destroyed. By the end of the War, only around 40,000 people were still living in the city area. After initial thoughts of giving up the old area, work began in 1947 to rebuild the Old Town. Post-war architecture still characterises the face of Cologne today. The Rhine metropolis is now the fourth largest German city and one of the most prominent travel destinations in Germany and Europe.

The Cologne museums rank amongst the best in the world and have enormous appeal for cultural tourism. Cologne is also becoming increasingly popular as a city of music and events. Every year the Koelnmesse is home to around 55 international trade fairs and welcomes more than two million visitors. In addition, the shopping streets, shopping arcades and a variety of restaurants have continued to attract more and more visitors over recent years.

Cologne is a lively cultural metropolis. Thanks to an extremely active and committed urban scene the city has developed into a creative hotspot. This is reflected above all in the numerous facets of design, music, art, fashion, festivals, and food.

Scope and Objectives

The 15th 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.

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

Abba Eban

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:

- Sustainability comparisons and measurements (metrics and indices; multi-criteria analysis; external costs; exergy analysis; footprint methods; emergy; 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)
- Smart energy systems (markets; demand response; integration of power, heating/cooling, transport, water and waste sectors; smart grids; dynamic electricity pricing, microgrids)
- Energy 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)
- Water-energy nexus (water management; water system analysis; water pricing; water desalination; hydro energy; water-renewables integration, water resources; river basin management; arid areas)

"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)

- 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)
- Sustainable tourism (green hotels; certification)
- Urbanism (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)
- Research, innovation and development (industry-academia partnership; quadruple helix; knowledge based society; knowledge management; learning curve; technology foresight; science diplomacy)
- Education in sustainable development (governance; environmental awareness; higher education; engineering education)
- Energy system analysis (energy planning; power system planning; smart energy systems; smart energy networks; natural gas 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)
- Transport management (transport system analysis, dynamic road pricing; electrification of transport)
- Renewable energy resources (biomass; hydro; wind; solar; geothermal; wave and ocean; technical and economic potentials; barriers; cost and benefits; integration)
- Primary energy resources (oil peaking; gas; coal peaking; nuclear fuels)
- Renewable electricity generation systems (biomass; hydro; wind; offshore wind; high altitude wind; photovoltaic; concentrated solar thermal power; geothermal; wave; tide; ocean thermal)
- Thermal power plants (clean coal; combined cycles; advanced cycles; flexible operation and cycling; carbon capture and storage/sequestration/reuse; nuclear)
- District heating and/or cooling in smart energy systems (integration of renewable heat; cogeneration; industrial waste/excess heat; waste to energy and CHP; power to heat;

electric boilers; heat pumps; integration of CHP with district heating and electricity markets; heat maps; distribution)

- 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)
- 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; BTL; biorefineries; alternative fuel vehicles; 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; DME; CNG; resources; production; vehicles; infrastructure)
- Hybrid and electric vehicles (first generation hybrid; plug in hybrid; charging; batteries; infrastructure)
- Water treatment for drinking water
- Water desalination (distillation; reverse and forward osmosis; electrodialysis; energy recovery; discharge management)
- Waste and wastewater treatment and reuse (avoiding waste; composting; recycling; waste to energy; anaerobic digestion; gasification; mechanical biological treatment; mechanical heat treatment; plasma arc waste disposal; pyrolysis; RDF/SRF; combustion modelling)
- Modelling for pollution avoidance and energy efficiency (CFD models; air pollution spreading; water pollution spreading; heat and mass transfer modelling 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 (heat/cold storage; hydrogen storage; hydropower as storage; pump storage; compressed air storage; batteries; water storage; biofuels storage; storage optimisation modelling; financial support mechanisms; power market arbitrage)
- Electricity transmission and distribution (grid extension and robustness; long distance transmission; power quality)
- Gas security of supply (diversification; shale gas; extension of transmission pipelines; LNG; Southern Corridor)
- Energy and water 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)
- Energy efficient appliances (smart appliances; labelling and standards; user behaviour)
- 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; heat pumps; storage; sustainable architecture)

- Energy markets (market/price coupling; liberalisation/deregulation; modelling; demand response; role of district heating; desalination and water pumping; storage; retail markets; grid parity; net metering)
- Emission markets (emission trading system; cap and trade; transport participation)
- 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)

"Then I say the Earth belongs to each generation during its course, fully and in its right no generation can contract debts greater than may be paid during the course of its existence"

Thomas Jefferson, September 6, 1789

In addition, acknowledging that regional coordination is the only feasible solution for gaining synergy effects for the small and only partially connected emerging energy markets of the Southeastern Europe, the Conference will address the core goals of the Energy Community and the wider region:

- Competitive integrated regional energy market (regional cooperation, market opening, price reform, regulatory framework and independence, coordination on regional projects, market coupling)
- Security of supply (diversification of fuels, energy efficiency, oil and gas storages, regional emergency response, energy and water scarcity)
- Climate change and environment (regional emissions reduction plans, fuel mix in power generation - renewable energy - gasification - energy efficiency, intelligent use of energy)
- Infrastructure development (Mediterranean power ring, Southern Corridor, investment projects of regional interest - minimum definition criteria, investments in the gas sector, electricity interconnections, grid access and integration of renewable energy)
- Social dimension (energy poverty, definition of vulnerable customers, protection schemes, stepwise phasing out of regulated energy prices, fossil fuel subsidies)
- External relations in light of sustainable development (enlargement - EU neighbours, cooperation with other international organizations)

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. Maria da Graça Carvalho

Chair of the International Scientific Committee

Prof. Ivo Šlaus

Chair of the Scientific Advisory Board

Prof. Ingo Stadler

Chair of the Local Organising Committee

Prof. Neven Duić

SDEWES Centre President

Prof. Zvonimir Guzović

Conference Secretary

BOOK OF ABSTRACTS

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Flexibility Options to Tackle Intermittency in the Energy Systems with High Share of Renewable Energy

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Abstract

Recent "Green deal" of European union includes the decision to become carbon neutral and even carbon-negative region in order to tackle the climate crisis. Such decision includes energy transition from energy production based on fossil fuels to the system based on variable renewable energy sources. Main technical challenge and a key factor in the techno-economic analysis of the energy system of the future, based on variable renewable energy sources, is their variable production. In order to deal with this problem in long-term energy planning, different approaches have been tried, focusing on overcapacity, storage capacities and sectors coupling with heating and transport. In this research, different flexibility options, storage and demand response technologies are modelled on several levels of energy systems: national, regional and continental. With the case study area including all EU countries modelled in EnergyPLAN model, the goal of the research is to show how each flexibility option influences the production capacities of renewable energy source technologies, storage technologies and demand response in order to reach a certain share of renewable energy in final energy consumed. Climate differences were taken into account for modelling of the behaviour of flexibility options, which is shown to be relevant for the creation of their representative curves. Representative curves are created as functions of critical excess electricity produced and share of renewable energy integrated into the system. Results show representative curves of most relevant flexibility options for several regions of EU and for the whole EU as one region. These results are further discussed in terms of strategic decisions addressing the dynamics of integration of such technologies, i.e. deciding on the priority of their integration in the energy system of the region in consideration. Results of research can be applied for integrated assessment models, in long-term planning of energy transition towards carbon-negative energy systems.