UNESCO sponsored Conference

7th CONFERENCE ON SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

BOOK OF ABSTRACTS

July 1 – 7 2012, Ohrid, Republic of Macedonia

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Conference Venue: Ohrid

“If you bathing in Lake Ohrid on a sunny day and suddenly emerge from its depths, breaking the surface for a moment, you will see on the pale blue expanse all around you silvery, transparent bubbles, big and small. In each of them the Sun is doubly reflected, like two focuses of different sizes. Approaching one of the bigger bubbles, holding your breath for fear it may burst, you can see in it, as in a distorting mirror, the reflection of your face, wet and laughing. And all the time, that bigger sun, like a vast star, hangs over your head. It all lasts for just an instant, like all beauty, yet it is repeated over and over again”...

Ivo Andric, Nobel Laureate (excerpt from travelogue "Beside Luminous Lake Ohrid")

“Don't let that powerful water mesmerize you with sleep. It has such a power: it mesmerizes you to sleep, enchants you, and then attracts you to itself with its magic. And you will stay in Ohrid for many days and years, and you will keep coming back.”

Branislav Nušić, Writer (excerpt from travelogue “On the Shores of Lake Ohrid”)

"No other lake contains so many different species of fish, especially the fish called eel... The lake is the elixir of life."

Evlya Chelebi, Ottoman traveler who journeyed the Ottoman Empire over 40 years

The City of Ohrid resembles a white swan embedded in the sorrounding deep blue water and indigo mountain scenery. Suspended on the rock, the town raises on the northern shores of the lake high above the water, reflecing its beauty in the crystal clear waters. The Lake od Ohird, one of the deepest and oldest in Europe, was once surrounded by 365 churches, one for each day of the year, some dating from the 4th century. The rich architecture is embellished with numerous monasteries, churches and mosques, and ancient relics dating back 3,800 years. Those jewels of Byzantine architecture, warm, touching and mystical, rightfully crowned the city to as the "Balkan Jerusalem" or "European Jerusalem".

Greek Lihnidos, Illyrian Desaretia, Roman Via Egnatia, Sts. Kliment and Naum, Tzar Samuilo, the fascinating Churches of St. Sofija, St. Pantelejmon, St. John Kaneo, St. Naum, the events and actors have changed through time, but the city suspended on the rock, stood still, outliving it all. Its name and glory stood the tests of time, proving to be everlasting and everbeautiful. It is small wander then, that this world wander is included in all top-turist destinations. Recently it was listed among top 10 best value destinations by Lonely Planet, included in the 30 world cities recommended to tourists by New York Times, and profoundly promoted on CNN and National Geographic, as well as other media.

Scope and Objectives

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Report of the U.N. Brundtland Commission, Our Common Future, 1987

The 7th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES Conference, to be held in Ohrid in 2012, is dedicated to the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from natural resources and replacing them with knowledge based economy, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water, environment and food production systems and their many combinations. Sustainability being also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the SDEWES Conference has during the first decade of the 21st century become a significant venue for researchers in those areas to meet, and originate, discuss, share, and disseminate new ideas.

"*...We, the representatives of sustainability science:-*
URGE
1. Governments and investors to maximize the benefits to all three of the pillars of sustainable development which arise from sustainable energy deployment, particularly distributed generation, in the provision of "green growth", environmental protection and the social advantage of substantial local job creation, both temporary and permanent, from the high multiplier of jobs per unit of RE generation
...
AND CALL UPON
All of the worlds governments to both access the available sources of scientific knowledge and technological development and ensure that adequate resources are provided for the rapid expansion into new and further research and development in the science of sustainability and its application...."
From the 2011 Dubrovnik Sustainable Development Conference Declaration and Communiqué

"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

The scope of the Conference will continue to successfully cover the following areas (with examples in parentheses, but not confined to these examples only):

- Sustainability comparisons and measurements methodologies (metrics and indices, multi-criteria analysis, external costs, exergy analysis, footprint methods, emergy)
- Thermodynamics in sustainability

- Sustainable development as a driver for innovation and employment
- Green economy and better governance (Green New Deal, energy and environment for jobs and regional development, poverty eradication, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects)
- Decoupling growth from resources (potentials, models, costs and benefits, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects, de-growth)
- Decarbonisation (wedges, policies, potentials, models, costs and benefits, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects)
- Energy policy (security of supply, climate change mitigation, renewable energy support schemes, energy efficiency, employment generating, agriculture and forestry, financial mechanisms, tax, cap and trade, feed-in tariffs, green certificates)
- Transport policy (urban sprawl management, traffic management, congestion and road pricing, dynamic road pricing, modal management, alternative fuels, social aspects, rail vs. air)
- Water policy and the energy-water interaction (water management, wastewater management, water reuse, water pricing)
- Environmental policy (waste management, wastewater management, climate change, air pollution policy, water pollution policy, land management, biomass management, social aspects, emission tax, cap and trade, cap and trade vs. pollution tax)
- Agricultural policy (energy use in agriculture and food processing, food vs. biofuels, sustainability of biofuels production, sustainability of food subsidies, subsidies vs. free trade, new green revolution, R&D in agriculture, sustainability of GMO(Genetically Modified Organisms) vs. Terroir)
- Environment and corporate social responsibility (quality management systems, environment management systems, eco management and audit sheme, occupational health and safety assessment systems, hazard analysis and critical control point, integrated management systems)
- Employment and energy, transport, water and environment systems (technology development, equipment production, installation, maintenance, macroeconomic analysis, financial and regulatory mechanisms, national, regional and municipal policy)
- Technology transfer and development (emerging markets, developing countries, least developed countries, clean development mechanism, new opportunities)
- Social acceptance (reform, NIMBY, nuclear, wind, biofuels, hydrogen, hidden and special interests)
- 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 (energy systems, transport systems, water systems, environment systems, green hotels, certification, labelling proliferation)
- Urbanism (urban planning, zoning, transport, modal shift, zero energy buildings and energy system planning, district heating, district cooling, Civitas, Concerto)
- Regional planning and cooperation (energy and environment for jobs and development, financial and regulatory mechanisms, obligations and standards,

energy and resource flow optimisation, 100% renewable regions, regional cooperation and networking, sustainable development across international borders)

- Sustainable islands (energy and environment for jobs and development, financial and regulatory mechanisms, obligations and standards, energy and resource flow optimisation, 100% renewable islands, islands networking)
- Research, innovation and development (demand side funding, supply side funding, researchers mobility, intrasectorial mobility, industry-academia partnership, knowledge based society)
- Education in Sustainable Development (Governance, Environmental Awareness, Higher Education in SD, Engineering Education in SD)
- Cooperation for Development (International Development Mechanisms, Clean Development Mechanisms, emerging markets, least developed countries, etc.)
- Energy system analysis (Energy system analysis models, tools and methodologies, Energy system analysis surveys and results)
- Water system analysis (models, tools and methodologies, surveys and results)
- Transport system analysis (models, tools and methodologies, survey and results)
- Life cycle assessment, Environmental impact assessment, Eco-design and Eco-labelling, Product cycle assessment
- Energy planning (power system planning, smart energy networks, natural gas system planning, high penetration of renewables, island energy systems, development of energy planning tools, internalizing environmental externalities, electrification of transport)
- Transport management (modelling, optimisation, tracking, GPS/mobile systems, dynamic road pricing system implementation, electrification of transport)
- Renewable energy resources (forest and agricultural biomass, biofuels, second generation biofuels, biogas, hydro, wind, solar, geothermal, wave and ocean, technical and economic potentials, barriers, cost and benefits)
- Primary energy resources (oil, gas, coal, uranium, thorium, oil peaking)
- Water resources (surface, ground, desalination, etc.)
- Food and agriculture (energy and water use, environmental impact, financial mechanisms, subsidies, free trade, impact of biofuels, new green revolution, R&D, GMO, biogas, using renewables in agriculture, solar and wind energy in agriculture)
- Renewable electricity generation systems (biomass, grid and fluidized bed, biofuels, biogas, hydro, wind, photovoltaic, concentrated solar thermal power, geothermal, wave, tide, ocean thermal)
- Thermal power plants (clean coal, fluidized bed, combined cycles, advanced cycles)
- District heating and/or cooling infrastructures in future energy systems (Integration of renewable energy heat supply, Cogeneration, waste incineration and CHP, heat pumps, integration of CHP with district heating and electricity markets).
- Nano and micro technologies and science for sustainable development of energy, water, and environment systems
- Carbon capture and storage/sequestration (oxy-fuel combustion, pre-combustion capture, post-combustion capture, CO2 transport, enhanced oil/gas recovery, enhanced coal bed methane recovery, chemical fixation, aquifer storage, bedrock storage, ocean storage, leakage)

- Nuclear energy (new power plant designs, waste, proliferation, fusion, transmutation, sustainability, policies, social acceptance)
- Advanced sustainable energy conversion systems (fuel cells, thermoelectric, thermionic, organic, ORC, waste heat recycling)
- Pyrolisis, torrefaction
- Renewable heat systems (biomass, biofuels, biogas, solar, geothermal)
- Biofuels and biorefineries (biodiesel, bioethanol, second generation biofuels, anaerobic digestion, BTL, biorefineries, vehicles, infrastructure, combustion modeling, sustainability assessment, pyrolisis, torrefaction)
- Hydrogen production and use technologies (stationary, mobile, small applications, electrolysis, reforming, nuclear hydrogen, infrastructure)
- Hybrid and electric vehicles (first generation, plug in, charging, batteries, infrastructure)
- Other alternative fuels (BTL, DME, CNG, resources, production, vehicles, infrastructure)
- Water treatment (methods, health issues, standards, grey water)
- Water Desalination (distillation, reverse and forward osmosis, electrodialysis, energy recovery, discharge management)
- Wastewater treatment (municipal, industrial, agricultural)
- Waste treatment (composting, incineration, landfill, anaerobic digestion, gasification, mechanical biological treatment, mechanical heat treatment, plasma arc waste disposal, pyrolysis, recycling)
- Waste to energy (incineration, landfill gas capture, biogas, RDF, cement industry, tyres, combustion modelling)
- Recycling waste (glass, paper, metals, containers, tyres, textiles, batteries, biodegradable waste, electronic waste, separation, financial schemes)
- Pollution modelling (CFD models, air pollution spreading, water pollution spreading, combustion modelling)
- Heat and mass transfer modelling (CFD models, energy efficiency)
- Cogeneration (heat and power, water and power, biofuels and power, transport and energy, food and energy, waste to energy)
- Trigeneration, polygeneration
- Storage (heat storage, hydrogen storage, hydropower as storage, pump storage, compressed air storage, batteries, water storage, biofuels storage, storage optimisation modelling, financial support mechanisms, maximising renewables, optimising load, power market arbitrage)
- Electricity transmission (grid extension and robustness, long distance transmission, automation)
- Smart energy networks (smart meters, dynamic electricity pricing, ICT, network-user interface)
- Energy efficiency in industry and mining (cement and lime, construction material, glass, pulp and paper, food industry, metallurgy, chemical industry, process optimisation, kilns, boilers, heat exchangers, pinch analysis, exergy and exergoeconomic analysis, energy audits, waste minimisation)
- Energy efficiency in agriculture and aquaculture
- Energy efficient appliances (smart appliances, labelling and standards, user interfaces, user behaviour)

- Buildings (zero energy buildings, passive buildings, smart buildings, smart metering, ICT, load and demand side management, green buildings, building standards, heating, ventilation, air-conditioning, cooling, insulation, renewables, heat pumps, storage, sustainable architecture, buildings certification)
- Energy markets (liberalisation, deregulation, spot markets, pools, storage, renewables, merging and acquisitions, modelling)
- Emission markets (Emission trading system, carbon taxing, carbon markets, GHG, SOx, CER, ERU, AAU, EUA, certification standards, VER, air transport participation)
- Political aspects of sustainable development (long term planning, the role of political leaders and of voters, international conflict vs. sustainable development)

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 South East European Region, the Conference will address the core goals of the Energy Community (which regional aspects, after the recent enlargement, go beyond the geographic Western Balkan area):

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

Preface

The objective of the 7th Conference 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 energy, transport, water and environment systems and their many combinations.

It is noteworthy that the 7th SDEWES Conference received over 600 abstracts that were peer-reviewed and nearly 220 papers were accepted and are included in the corresponding electronic proceedings. The organizers wish to express their gratitude to all these authors for having taken interest in the conference and for their valuable contributions. We sincere thank the Members of the International Scientific Committee and the Members of the Scientific Advisory Board who devoted much time for reviewing the abstracts and papers, as well as to other reviewers, who contributed to the success of this conference and to the quality of these proceedings. We are also grateful to our colleagues, the members of the Local Organising Committee and to all those who contributed in many ways to the organization of the conference. Special thanks are extended to the keynote speakers, invited lecturers and panellists.

We would like to welcome all the participants of the 7th SDEWES Conference coming from 45 countries. We trust that this conference will reach the goal of bringing together scientists and engineers and inspire them to generate more knowledge for tackling mankind's future problems. Last but not least, we would be happy if your stay in Ohrid, one of the UNESCO World Heritage sites, would be enjoyable, fruitful, happy and sunny.

Prof. Ivo Šlaus
Chair of the Scientific Advisory Board

Prof. Nataša Markovska
Chair of the Local Organising Committee

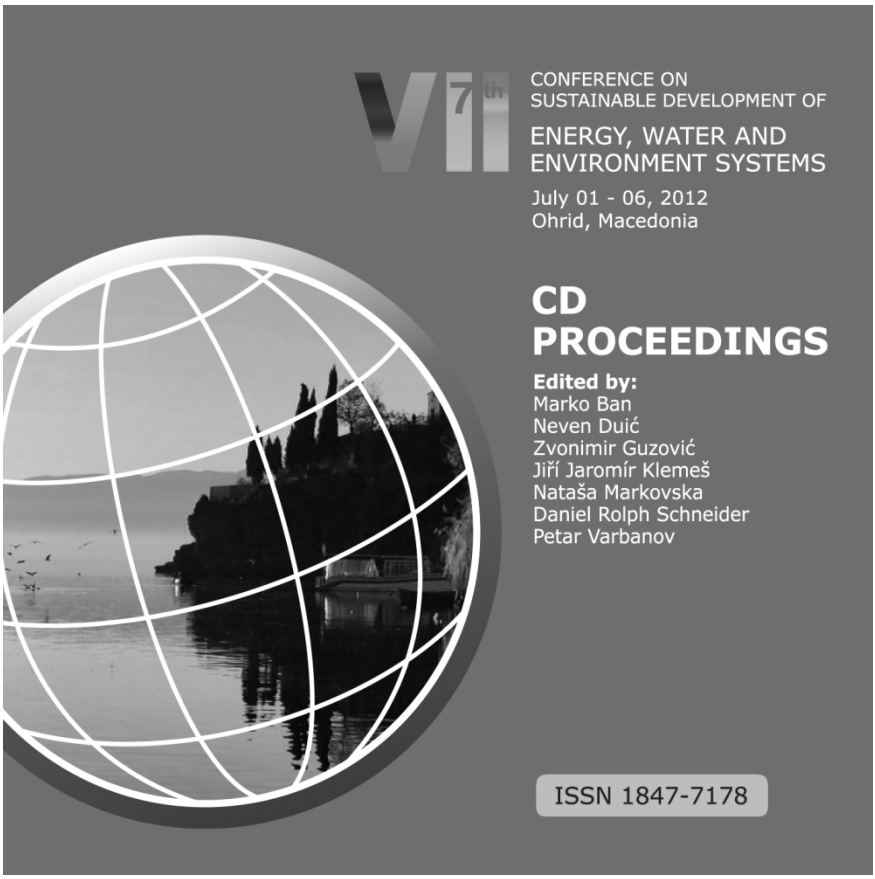
Prof. Zvonimir Guzović
Conference Secretary

Programme

Sunday, July 1	
17^{00} - 20^{00}	Registration
Monday, July 2	
9^{00} - 20^{00}	Registration
9^{00} - 16^{00}	Technical excursions
19^{45} - 22^{00}	Welcome reception
Tuesday, July 3	
8^{00} - 10^{00}	Registration
10^{00} - 11^{00}	Conference opening session (HALL A)
11^{00} - 12^{00}	Special opening session dedicated to the 25th anniversary of "Our Common Future" report (HALL A)
12^{00} - 12^{30}	Coffee break
12^{30} - 13^{30}	**Invited lecture**: Dr. Subhas K. Sikdar Claims and Verifications of Sustainable Technologies (HALL A)
13^{30} - 14^{30}	Lunch
14^{30} - 16^{30}	Parallel sessions Special session: Smart grids (HALL A) *Chair: Prof. Borozan* *Co-chair: Ms. Krkoleva* Energy planning I (HALL B) Life cycle assessment (HALL C) Energy system analysis I (HALL D) Water policy and the energy-water interaction (HALL E) Agriculture and Food (HALL F)
16^{30} - 17^{00}	Coffee break
16^{30} - 16^{45}	Launch of the book "The Brazilian economy during the 70s and the 80s: Let's focus on 'sustainability'" by Dr Jacques Ribemboim
17^{00} - 19^{00}	Panel: The energy security of Southeast Europe – the role of coal (HALL A)
19^{00} - 23^{00}	International Scientific Committee meeting (by invitation)
Wednesday, July 4	
8^{00} - 9^{00}	Registration
9^{00} - 11^{00}	Parallel sessions

	Special session: Energy and water efficiency for sustainable future (HALL A) *Chair: Dr. Varbanov* *Co-chair: Prof. Klemeš* Renewable energy resources (HALL B) Energy system analysis II (HALL C) Energy planning II (HALL D) Energy economics/ Externalities (HALL E)
11^{00} - 11^{30}	Coffee break
11^{30} - 13^{30}	Parallel sessions Special session: Energy and water efficiency for sustainable future (HALL A) *Chair: Dr. Varbanov* *Co-chair: Prof. Klemeš* Energy markets (HALL B) Biofuels and biorefineries I (HALL C) GHG emissions (HALL D) Wastewater treatment (HALL E) Research (HALL F)
13^{30} - 14^{30}	Lunch
14^{30} - 22^{00}	Excursion and dinner
	Thursday, July 5
8^{00} - 9^{00}	Registration
9^{00} - 10^{00}	**Invited lecture**: Prof. Jiří Jaromír Klemeš Integration of Energy and Resource Flows (HALL A)
10^{00} - 10^{30}	Coffee break
10^{30} - 12^{30}	Parallel sessions Special session: Energy and water efficiency for sustainable future (HALL A) *Chair: Dr. Varbanov* *Co-chair: Prof. Klemeš* Energy policy I (HALL B) Buildings I (HALL C) Sustainable development (HALL D) Renewable electricity generation systems I (HALL E) Transport (HALL F)
12^{30} - 13^{30}	Lunch
13^{30} - 15^{30}	Parallel sessions Special session: Energy and water efficiency for sustainable future (HALL A) *Chair: Dr. Varbanov* *Co-chair: Prof. Klemeš* Energy policy II (HALL B) Regional planning and cooperation (HALL C)

	Recycling waste (HALL D) Environmental policy and practice (HALL E) Water system analysis (HALL F)
15^{30} - 16^{00}	Coffee break
16^{00} - 18^{00}	Panel: Academia – industry collaboration in sustainable developement (HALL A)
18^{00} - 18^{30}	Coffee break
18^{30} - 20^{30}	Parallel sessions Biofuels and biorefineries II (HALL A) Cogeneration and district heating (HALL B) Sustainability comparisons and measurements methodologies (HALL C) Energy efficiency; in industry and mining, appliances (HALL D) Waste management (HALL E)
Friday, July 6	
9^{00} - 10^{00}	**Invited lecture**: Prof. Mousa Mohsen Water Scarcity: Non-conventional Water Resources Supply in Jordan (HALL A)
10^{00} - 10^{30}	Coffee break
10^{30} - 12^{30}	Parallel sessions Renewable electricity generation systems II (HALL A) Primary energy resources (HALL B) Buildings II (HALL C) Cooperation and development/Technology transfer (HALL D) Water resources (HALL E)
12^{30} - 13^{30}	Lunch
13^{30} - 15^{00}	SDEWES Award and closing session (HALL A)
Saturday, July 7	
7^{00} - 22^{00}	Post conference exc.



To this Book of Abstracts, an electronic draft Proceedings is enclosed, containing all submitted manuscripts in full. The final version of the Proceedings will be available to participants online after the Conference.

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BOOK OF ABSTRACTS

Invited lectures

SDWS2012.0563 Claims and Verifications of Sustainable Technologies

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Abstract

Claims of both sustainable and unsustainable technologies need to be substantiated quantitatively. If we accept the premise that current technologies can be continually improved in terms of economic benefit, societal good and environmental performance, all current technologies can be understood to be relatively unsustainable. It is however conceivable that with a particular technology providing a particular service, there can come a point from which no further improvement in any of the three domains of sustainability can be achieved. At that point, we will have achieved a sustainable technology. Since we will not know when that situation will arise, we should judge sustainability in relative terms. More sustainable technologies, therefore, are what we would be seeking. There are however many claims of sustainable technologies, the so-called green washing, that have not been presented with quantitative assessment based on metrics or indicators that cover the sustainability concerns. Typically they would be addressing only one prominent concern, most frequently it appears to be global warming. To elicit credibility, this situation has to change by incorporating all potential indicators of sustainability.

There are many types of sustainable systems at global, regional, institutional and technology scales that are considered and reported upon. In this talk only the technology scale will be considered. The first order of business in a sustainability analysis with an eye to ascertain if a technology is more sustainable than another serving the same function, suitable quantitative metrics or indicators need to be chosen. It must be assured that all three dimensions of sustainability will be sufficiently covered. It is possible that some indicators will have attributes that would be over-represented, thus introducing bias in the analysis. Thus a prioritization of the indicators should be conducted to yield the number of necessary and sufficient indicators. Lastly a quantitative analysis must be performed to show that one option is clearly superior to the rest from a sustainability viewpoint. This presentation will show the recent advances made in each of these elements of the process of analysis with examples of industrial systems.

SDWS2012.0550 Integration of Energy and Resource Flows

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Abstract

The increase in the world population that has occurred has placed increasing pressure on the demands of world society, and especially that of industrial and agricultural production. The accelerating development of countries with large populations has resulted in increased demands on agricultural production and processing, which resulted in further increases in energy and water demands. The supplies sharply increase in cost and many cases of shortages of all forms of energy and water are witnessed.

The resources for energy supply have been limited. Clean water availability is limited as well and mostly water requires energy to be cleaned and delivered. A key task is to deliver the resources to the demand locations. This creates logistic and in many cases political problems.

Fossil fuel resources and delivery has been of paramount importance to industrialised countries and cause considerable struggle resulting in many conflicts. Nuclear energy can be generated in the region of the needed consumption. However, it raises safety and environmental issues. Renewable sources can be harvested inside or close to the region of consumption. However, they have problems with variable availability in time, intensity and handling their supply flows.

A similar situation has been developing in water and fresh water supply and waste water minimisation. This has been also related to industrial and agricultural development as well as increasing civic demand and consumption. Water is very often used hot or chilled which requires energy. What solutions improving the state-of-the-art can be offered by advanced engineering? The solution of the energy and water flows on the global scale demands enormously extensive models supplied with the large volume of data. To the some scale this can be dealt with, however on global forum are political interests of various key players outside the reach of engineering studies.

Based on the analysis of present situation a well rehearsed engineering bottom to top approach is suggested. There have been very successful real life studies and even implementations delivered for total sites:

- Starting from traditional industrial complexes (total sites)

- Extended total sites – covering industrial complexes and neighbouring smaller industrial, civic residential, business, service and even agricultural complexes
- Total sites exploiting renewable energy sources mainly locally produced
- Regional sites, considering a wider scale consumption and especially renewable supply based on biomass.
- Specific largely isolated sites as island and remote regions

A methodology has been under progressing development for both energy and water supply and for optimisation of emission/effluents treatment flows. The main guiding principle is to minimise the net resource intake/demand of the considered systems at each level. The presentation provides an overview of the most recent developments in the field and potentials future research directions.

SDWS2012.0521 Water Scarcity: Non-Conventional Water Resources Supply in Jordan

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Abstract

Jordan is considered one of the countries in the world with the scarcest of water resources. This has led to deterioration of the groundwater quality and an increase in the salinity levels. The dominant environmental challenge facing Jordan is the scarcity of the Kingdom's water resources in an arid land with unpredictable rainfall and an expanding population. Rainfall is confined largely to the winter season and ranges from around 660 mm in the north west of the country to less than 130 mm in the extreme east. Major surface water resources are the Yarmouk and Zarqa rivers, and the associated side wadis, all flowing westward into the River Jordan and the Dead Sea. Whilst high evaporation rates result in relatively low annual stream flows, the high infiltration rates common in Jordan result in high rates of groundwater recharge. Water conservation is being pursued through increased water recycling, improved irrigation techniques and reducing water loss in distribution; whilst on the supply side is examining the potential for increased desalination, including schemes to transport sea water from Aqaba to the Dead Sea to restore its level and generate potable water, and further investment in dams and domestic reservoirs to collect and hold rainwater.

Based upon comprehensive information on Jordan and the problems and constraints, there is a serious water problem; the demand is exceeding the supply, although all conventional sources have been developed. There is a clear necessity for developing non-conventional water supplies, and there should be a high alert towards the need for conservation, management, and efficiency enhancement measures within the water sector, i.e., an action plan should be developed and enforced: overall integrated water resources planning and development.

This paper reviews the basic water plans in Jordan, including water resources available, analysis of supply and demand, impacts of water scarcity, water management options, and current situation and future need of desalination, as the only realistic hope, energy requirements for desalination. Using a decision-support system through a multi-criteria analysis, an attempt was made to assist decision-makers to evaluate the various available non-conventional water resources in terms of economic, technical, availability, reliability and environmental sustainability.

Special opening session dedicated to the 25th anniversary of "Our Common Future" report

The eighties of the previous century mark a point in the history when awareness was growing about the risk for overstepping limits in the world, the need to adapt the use of natural resources to the long-term carrying capacity of the planet, as well as about the fact that unequal opportunity and unequal distribution of resources were at the heart of the problem. The predominant thinking at that time was: It is either the environment you can protect or it is the economy you can develop, but not both ways.

The Brundtland Commission faced this setting with a new political idea: A sustainable development is how it is recommended to face the challenge of meeting the needs of present generations without compromising the ability of future generations to meet their needs. This political concept includes equity and justice, within and between generations, and clear idea of developing a shared understanding of the long-term goals for human life on earth, new governance instruments and collective action.

Twenty five years later, this special opening session is aimed at celebrating 25th anniversary of the "Report on Our Common Future" - the most important point in turning the world towards a more sustainable future, by looking into sustainable development WHATs, HOWs and WHOs in some specific areas, as well as into national sustainable development policy perspectives of the host country.

Session chair
***Prof. Natasa Markovska**, Macedonian Academy of Sciences and Arts, Skopje, Macedonia*

Natasa Markovska holds DSc degree from the Faculty of Electrical Engineering, Skopje, with thesis on solar energy technologies. At present she is a Professor and Senior Researcher at the Research Center for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU). She is leading/participating in several research projects related to energy strategies, energy efficiency and renewable energy sources, as well as the environmental impacts of various energy technologies, including greenhouse gases emissions and climate change mitigation options. She is the Chair of the National Committee on Climate Change and National Focal Point of the Intergovernmental Panel on Climate Change. Prof. Markovska participated in the preparation of the Macedonian National Strategy for Sustainable Development, leading the working group on Energy.

SDWS2012.0606 Sustainable Development of Energy and Environment

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Abstract

The outcome of the work of the World Commission on Environment and Development, a report released in 1987, commonly known as the Brundtland Report was the first attempt to harmonize the prosperity and growth with Environment – the concept of sustainable development. The Kyoto Protocol from 1997, "commits" industrialized countries to stabilize their greenhouse gas (GHG) emissions under the principle of "common but differentiated responsibility". Today we are aware that the Kyoto targets are not going to be met. With the exception of the EU and several other countries, most parties to the Kyoto Protocol have failed in their attempts to reduce the use of fossil fuels. The main cause of an increased use fossil fuels is people's need for economic growth. At today's stage of technology in energy production, restrictions in using fossil fuels automatically provoke restrictions in economic development.

So far, our goals were ambitious, the expectations high but, unfortunately, the results achieved so far very modest. The only answer is the development of technology in the field of energy production and energy use. Therefore, a political agreement which would ensure the support and prerequisites for substantial investments in the development of technology worldwide is needed.

The Copenhagen Accord, a document adopted at the 2009 Copenhagen Conference sets a legal base for establishing the Green Climate Fund – a Fund through which substantial financial recourses are to be used for technology transfers and investments that are to support projects, programs, policies and other activities in developing countries related to mitigation and adaptation. That is, if we want to reach the agreement under UNFCCC, the negotiations on the post-Kyoto should take into consideration two crucial elements, which are to create a political and scientific setting for substantial investments in the development of technology:

- investments of the most developed counties into the Green Climate Fund (100 billion dollars per year by 2020, and further augmentation);
- general (not binding) agreement on the reduction of GHG emissions.

The possible solution of investments of 100 billion dollars a year in new technologies for GHG emission reduction would create bigger interest for investment in R&D. The competition in development of new technologies would prosper and develop the new

equipment with lower prices of renewable energy production to the level of fossil fuel energy production. Even below.

Consequently, there is an urgent need to develop projects in the fields of the renewable energy production, of (portable) energy storage and the flue gas conversion or underground storage.

This will enable new market investments based on an adequate financing system and accessible technology for developing countries.

In short we need a policy for sustainable energy future.

SDWS2012.0604 Microgrid Roadmap: Sustainable Energy Strategy for Small Power System

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Abstract

A Sustainable energy strategy can be presented in different levels: as a global policy, and regional, local, and small community strategy. Moreover, different sectors across the region or countries, public and private companies and institutions can address energy challenges.

Traditional energy systems (centralized grids) - Macrogrogrids are economically, environmentally and socially unsustainable. There is a growing awareness of the need for smart grids to be deployed in both existing systems as well as within totally new systems, to develop a path to global sustainable energy strategy.

"The endpoint of smart grid deployment is expected to be similar across the world, but the roads and time it takes to get there could be quite different." (Bazilian, 2011). Developing countries with limited financial resources need to develop their national sustainable energy strategies as well. This can be achieved step-by-step, with the implementation of microgrids as a small size power system connected to community grids that can then connect to national and regional grids. A microgrid as a smart grid laboratory by definition represents a small power system.

A microgrid as a roadmap for sustainable energy strategy for a small power system can be seen as a first step forward, a "bottom-up" approach in building a national smart energy system. A number of actions in different levels and different size can be taken, from

housing estate, community, region, and country. A combination of national and local strategic planning may result in action plans being successful and targets met.

One concrete example of a Sustainable Energy Strategy for Small Power System in the ongoing project of the SEEU Campus.

SDWS2012.0605 Our Common Future - 25 Years Later

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Abstract

Our Common Future, also known as the Brundtland Report, was published in 1987. Its targets were multilateralism and interdependence of nations in the search for a sustainable development path. It has set up the framework for combining the environment and development as one single issue, putting it strongly on political agendas. Twenty five year later what has been was achieved? Poverty has been reduced but not been eradicated, protection of environment has been enshrined in all strategies, but we are witnesses of massive loss of habitats and the onset of anthropogenic climate change. The problem is that, 25 years later, sustainable development remains a generally agreed concept, rather than a day-to-day, on-the-ground, practical reality. It is difficult to argue against the principles of sustainable development, but there are few incentives to put it into practice when our policies, politics and institutions reward the short term. In other words, the policy dividend is long-term, often intergenerational, but the political challenge is often immediate. The environmentalists were always suspicious of combining goals. The Washington consensus, which governed for most of the time since the report, has concentrated on development, while developing countries focused on social equity. During a period of time, sustainable development was epitomised by climate change mitigating process, which failed, due to combined political resistance of both camps, the Washington consensus and the social equity. The green economy, based on attempt to internalize external costs, might be the next try to come back to initial goals of the Brundtland Report.

Special session: Smart grids

The power systems have been evolving for more than a century, becoming complex systems that provide a number of services to the modern society. In the last decades, substantial changes occurred due to the liberalization of the electricity markets, the integration of renewable energy sources and the general commitment to reduce the greenhouse gas emissions. Apart from these aspects, which are still in the focus of the electricity sector stakeholders, the future electricity grids will have to address new, additional requirements regarding security and quality of supply, network accessibility for various actors, including distributed generators using renewable energy sources, flexibility in fulfilling the needs of the customers and integration of emerging technologies, especially effective low cost technologies with low carbon emissions. In this context, Smart Grids have become the platform for developing different solutions that will enable the future electricity grids to fulfill these requirements. In other words, the Smart Grids have become an integral part of the vision for development of the future electricity systems. Becoming "smart" actually signifies that the future electricity grids will incorporate solutions that will increase the role of the customers by enabling market opportunities, value added services, and providing access to the network for customer owned small scale (micro) generation units. From the aspect of grid operation and control, the Smart Grids will include new, effective solutions for demand side management, local energy management, losses reduction and integration of distributed generation and storage. The Smart Grids will help achieving sustainable development by using efficient, environmentally-friendly and cost effective energy sources. This will impact emissions reduction and allow higher share of renewable energy sources in the electricity systems.

The actual deployment of Smart Grids is still in early stage, with numerous pilot projects addressing different aspects of the future Smart Grids. At present, coordinated research actions, intensive communication between stakeholders and adequate, harmonized policy development are needed in order to harvest the benefits of large scale Smart Grids deployment in future. In this context, the aim of the proposed session is to discuss different aspects of Smart Grids, with emphasis on current research and pilot project experiences. The impacts of Smart Grids on sustainable development and environment protection will be also addressed.

Session organizers:
***Prof. Vesna Borozan**, University Ss. Cyril & Methodius, Skopje, Macedonia*
***Ms. Aleksandra Krkoleva**, FEIT, UKIM, Skopje, Macedonia*

Vesna Borozan received her doctoral degree in 1996, from the University of Belgrade, Serbia. She was a Postdoctoral Fellow at the North Carolina State University, NC, USA in

1997 and a Visiting Professor at the Pontificia Universidad Catolica de Chile, Santiago de Chile, Chile, in 1999. Presently she is an Associate Professor in Power Systems at the Faculty of Electri¬cal En¬gineering and Information Technologies, Uni¬versity "Sts. Cyril and Methodi¬us", Skopje, Macedonia and a Honorary Professor on Power Systems at the Vienna University of Technology, Vienna, Austria. Her subjects of inte¬rest include electricity market and regulation, power and distribution sys¬tem operation and planning, as well as, integration of dispersed generation into the grid and smart grids. She is an author or coauthor of many scientific publications. In the period 2002 – 2006, being a member of a number of governmental commissions and working groups and an energy adviser of the Prime Minister, she gave an important contribution to the initial restructuring of the electricity sector in Macedonia and market liberalization. She is senior member of IEEE, member of CIGRE and a cofounder of the European Center for Environmental Economy (ECEE).

Ms. Krkoleva was born in Skopje. She has received BSc and MSc degrees in engineering from "Ss Cyril and Methodius" University in Skopje, Faculty of Electrical Engineering and Information Technologies (FEIT) in 2003 and 2007 respectively and currently she is working towards her PhD degree. Since 2007, she is teaching and research assistant at FEIT. Her research interests include distributed energy resources integration, Microgrids, electricity markets and computer applications in power systems. She has published more than 30 scientific papers and has been a member of the research teams in the EC financed research projects: RISE (2004-2007, FP6), More Microgrids (2007-2009, FP6) and SEETSOC (2010-2012, FP7). She is member of IEEE-PES and Mako CIGRE

SDWS2012.0358 Smart Grid in Russia: Today's and Tomorrow's Practices

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Abstract

The paper describes the smart grid to be created in Russia, its technological platform, requirements imposed, main problems, technologies, and lines of work to be performed. The overview is made on the basis of materials provided by the JSC "Federal Grid Company of Unified Energy System", which is the initiator and key coordinator of development and implementation of the intelligent energy system with active&adaptive network.

The main goal of the Technological platform "Intelligent energy system of Russia" is implementation of intelligent technologies in the Russian power industry to ensure an innovative breakthrough in development of the industry, and to increase the efficiency, reliability and security of its operation. An important role is assigned to the Active&Adaptive electric Network as the technological infrastructure of electric power industry, which in fact imparts principally new properties to the intelligent electric power system. The process of Intelligent energy system formation on the territory of the "East" and "North-West" Interconnected Power Systems (IPS) suggests implementation of pilot projects and creation of individual smart grid clusters, such as:

- Smart grid clusters in the "East" Interconnected Power System. In 2011 the projects on formation of individual smart grid clusters and implementation of pilot projects aimed at creating the smart grid were launched on the territory covered by the "East" IPS (Amur region, Sakha Republic, Primorye and Khabarovsk Territories). The territorial smart grid cluster on Russky and Popov islands involves creation of the automated control system for an Intelligent Energy System with the Active&Adaptive Network.

- Smart grid clusters in "North-West" Interconnected Power System. In the North-Western region of Russia the following pilot projects of Smart grid clusters will be implemented during the period till 2020: Karelskaya power system, Power systems of Komi Republic and Arkhangelsk, "Big ring" and "Small ring" of electric networks in St. Petersburg.

- Pilot project on power supply to the Skolkovo innovation center. For electricity supply to objects of the Skolkovo innovation center (the high-tech research and technological complex for design and commercialization of new technologies) nine main electric network facilities will be built and reconstructed during 2011-2014.

SDWS2012.0492 Control Strategies for Smart Grids

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Abstract

Smart Grids are considered as crucial development thread in the future power systems. The Smart Grids are envisaged as electricity networks that can intelligently integrate the actions of all grid users with the aim to provide sustainable, economic and secure

electricity supply. Smart Grids include various technologies and concepts which should allow connection of different types of distributed electricity generators and thus facilitate the use of renewable energy sources, provide environmental benefits and increase the role of the consumers in both network operation and market development. The Smart Grids provide new perspectives for solving current problems and redesigning the available technical solutions. Their development is based on innovative technologies for monitoring and control, enhanced communication capabilities and local intelligence. In this context, the linkage between the electricity and ICT sector is essential in creating the required environment for transition from power systems of today towards future Smart Grids.

The paper addresses a number of problems which can be alleviated by the deployment of Smart Grid technologies and concepts. The Smart Grids enable implementation of various control strategies based on Smart Grid technologies, such as smart metering, embedded systems, on-line services and communication technologies. These technologies will enable the different actors within the Smart Grid to exchange information/knowledge and to make decisions on local level based on the received information. By making local decisions, the distributed actors will achieve a designated global objective. The implementation of the control strategies is also based on algorithms which will enable efficient and reliable communication while avoiding extensive costs. Special emphasis is given on distributed approach in control based on the class of epidemic algorithms.

SDWS2012.0537 Smart Meter Communication Technologies

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Abstract

Smart energy meters are involved not only into data logging and transmission to a central database of the utility, but even more into power quality monitoring as well as into real-time indications and participation in new types of liberalized energy markets, which need immediate response and feedback. Therefore smart meters should base on reliable and without delays communication protocols. In this paper an overview of the communication protocols and techniques applicable to smart meters is attempted. The DLMS/COSEM standard provides meters with the appropriate specification of implementing the application layer. In the physical and data link layer a variety of technologies are suitable for smart meters, including Power Line Communication (PLC), Radio Frequency (RF) (such as ZigBee), GSM, 4G (including WiMAX and LTE – for Long Term Evolution). In PL communications an analog sign is superpositioned to the current, which is transferred through the conventional electrical cables. RF technologies make use of radio waves and

transfer data over the allowed unused radio bands of 3-30 MHz. 4G wireless technologies employ a base station and several repeaters and can cover large areas with low density of meters. The paper concludes describing the advantages and disadvantages of these communication technologies as concerned to the smart meters.

SDWS2012.0306 Considering the Needs of the Customer in the Electricity Network of the Future

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Abstract

The main purpose of the electric power system and the electricity network (power grid) is to supply electrical energy to the consumers. The interest of those consumers is in the price of electricity and in the performance of the delivery of the electrical energy. For the electricity producers, the aim of the grid is to enable the transport of electricity from them to the consumers. Also for the producers the importance is in costs and performance. Performance of the grid is typically divided into two parts: continuity of supply and voltage quality.

The appearance of the smart grid, introduced as the use of new technology, methodology or market principles, to address new challenges, impacts continuity of supply and voltage quality. Such challenges include new types of production, new types of consumption, and electricity markets, but also increasing demands by customers on continuity of supply and voltage quality.

This paper discusses a number of examples of new thinking for addressing the challenges that the power system has to cope with.

An alternative approach for overload protection of subtransmission grids will be proposed, where the “smartness” is in the fact that the overload protection does not remove the overloaded component but the cause of the overload. Upon detection of an overload, the protection disconnects part or whole of curtailable customers to reduce the current through the lines to a level below the overload limit. As a result subtransmission lines can be operated without any reserve, so that more customers can be connected for the same costs while at the same time the continuity of supply for the non-curtailable customers is not impacted.

The limits set to the hosting capacity by the risk of overvoltages due to distributed generation can be removed either by new technology (curtailment of production) or by allowing occasional overvoltages. An example will be provided to show the probability of an overvoltage occurring with a low-voltage customer when increasing amounts of wind power are connected to a medium-voltage feeder.

An example of the measured emission from wind turbines will be presented. Allowing higher levels of non-characteristic harmonics is a possible alternative for strict emission limits on new installations.

The provided examples of the use of new technology and/or new ways of thinking are part of the transition to the smart grid. Such new thinking in combination with new technology will be an important element in the transition to the future electricity network i.e. the "smart grid". With any design or operation issue of the power system it remains important to always keep the main aims of the power system in mind: to maintain acceptable continuity of supply and voltage quality for all network users at a reasonable price.

SDWS2012.0500 Multi-Agent Systems Strategies for Integration of Prosumers in Smart Grids

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Abstract

It is widely expected that the massive insertion of renewables and electrical vehicles at electricity distribution level will greatly impact grid stability and change existing power system paradigms. In such conditions each energy entity attached to the grid would be able to become an active participant in the energy market. A novel concept of 'prosumer' denotes energy entities that are able to produce and/or consume energy depending on their internal energy balance and external negotiation with Smart Grids (Demand Side Management). Efficient integration of these entities represents one of the fundamental challenges to be faced by future power systems. Many approaches as for instance active demand [FP7 project ADDRESS], aggregations [FP7 project Fenix], Distribute Energy Resources and Virtual Power Systems [InterReg project AlpEnergy] have been proposed as solutions. Some particular problems, such as coordinated electrical vehicles charging, have been considered as a mean to boost stability of power systems.

We propose introduction of Multi-Agent Systems (MAS) for 'prosumer' integration. MAS have been proposed as a strategy to cope with many issues in power systems, such as condition monitoring and diagnostics, power system restoration, market simulation, network control and so-forth.

We envision a system for prosumers' management based on:

- Flexible hierarchical architecture

- Modular structure based on adoption of MAS approach to 'prosumers' management.

The 'prosumer' management structure is based on existing corporate infrastructures, customizing them to provide data access to a larger corporate data mart, respecting the common standards associated with existing solutions as components of the agents. In spite of the Smart Grid research lead by IT integration, still very few utilities and energy market players take advantage of existing wealth of information. This is why we reflect on the selected representative 'prosumer' dependence on the level of integration and automation, establish data paths (operational, nonoperational and remote access data) and match users and data.

Key Performance Indicators for success of the applied model are indicated. Model is verified through simulation and benefits consist of:

- Improvement of connection and operation of 'prosumers' of diverse technologies

- Decision support system for production forecasting

- Market support tool

Simulations of more complex scenarios are summarized and proposed for future consideration.

SDWS2012.0117 Socioeconomic Impacts of Smart Grids

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Abstract

It is known the smart grids can contribute to reach the EU2020 energy targets moving towards new horizons like 2030 because they allows to use natural resources to generate electricity in urban areas, new electricity applications in mobility strategies and a more efficiency domestic use of energy by means of smart metering. It is common to find answers related with the technical considerations like: which will be the evolution in sales in smart domestics applications? How many vehicles can be switch in the actual grid? What will be the impact of the electric vehicle like a smart storage energy system promoting the distributing electricity generation?

In this sense, this paper offers some answers related with the smart grids and the economic aspects of them, in order to analyse suitable energy planning with effective energy politics that set the smart grids as a key factor inside the sustainability energy actions plans. A methodology of socioeconomic analyze has been specially designed in order to define future investments in smart grids, impact of them in the employment, different industrial sectors that will be involved, principal environmental benefits and, the socioeconomic impacts of these intelligent grids.

The aim of this paper is to present a methodology, the principal results obtained, and some conclusions about the contribution of the Smart Grids to the green economy growth. The method implemented has been applied to the city of Zaragoza as a case study, through which the method has been tested and the indicators have been selected.

In conclusion the smart grids are a key factor to reach the European energy targets but are not only a new technology, it suppose a new energy model that affect from generators to consumers so it is necessary to adopt a socioeconomic impact methodology to know what is the adequate energy strategies.

Special session: Energy and water efficiency for sustainable future

In 2011 this session received a considerable attention, which materialised in the number of invited lectures and number of attendees, as well as in the number of authors invited to publish the extended manuscripts in dedicated Special Issues of journals with a high Impact Factor.

Due to the high demand it has been decided to organise this session again in 2012.

Industrial production still requires a considerable and continuous supply of energy delivered from natural resources—principally in the form of fossil fuels such as coal, oil, and natural gas. The increase in our planet human population and its growing nutritional demands have resulted in annual increases in energy consumption. Furthermore, many nations have accelerated their development in the last 10 years, and countries with large populations (such as China and India) have seen even more significant increases in energy demands. This growing energy consumption has also resulted in unsteady climatic and environmental conditions in many areas because of increased emissions of CO_2, NO_x, SO_x, dust, black carbon, and combustion process waste.

It has become increasingly important to ensure that the production and processing industries take advantage of recent developments in energy efficiency and in the use of nontraditional energy sources. The additional environmental cost is related to the amount of emitted carbon dioxide (CO2) and may take the form of a centrally imposed tax. A workable solution to this problem would be to reduce emissions and effluents by optimizing energy consumption, increasing the efficiency of materials processing, and increasing also the efficiency of energy conversion and consumption.

Although major industry requires large supplies of energy to meet production targets, it is not the only sector of the world economy that is increasing its energy demands. The particular characteristics of these other sectors make optimizing for energy efficiency and cost reduction more difficult than in traditional processing industries, such as oil refining, where continuous mass production concentrated in a few locations offers an obvious potential for large energy savings. In contrast, for example, agricultural production and food processing are distributed over large areas, and these activities are not continuous but rather structured in seasonal campaigns. Energy demands in this sector are related to specific and limited time periods, so the design of efficient energy systems to meet this demand is more problematic than in traditional, steady-state industries.

In recent years there has been increased interest in the development of renewable, noncarbon-based energy sources in order to combat the increasing threat of CO2 emissions and subsequent climatic change. These sources are characterized by spatial

distribution and variations as well as temporal variations with diverse dynamics. More recently, the fluctuations and often large increases in the prices of oil and gas have further increased interest in employing alternative, non-carbon-based energy sources. These cost and environmental concerns have led to increases in the industrial sector efficiency of energy use, although the use of renewable energy sources in major industry has been sporadic at best. In contrast, domestic energy supply has moved more positively toward the integration of renewable energy sources; this movement includes solar heating, heat pumps, and wind turbines. However, there have been only limited and ad hoc attempts to design a combined energy system that includes both industrial and residential buildings, and few systematic design techniques have been marshaled toward the end of producing a symbiotic system.

Another important resource is water – both as raw material and effluent. Water is widely used in various industries as raw material. It is also frequently used in the heating and cooling utility systems (e.g., steam production, cooling water) and as a mass separating agent for various mass transfer operations (e.g., washing, extraction). Strict requirements for product quality and associated safety issues in manufacturing contribute to large amounts of high-quality water being consumed by the industry. In addition, large amounts of aqueous streams are released from the industrial processes, often proportional to the fresh water intake. Stringent environmental regulations coupled with a growing human population that seeks improved quality of life have led to increased demand for quality water. These developments have increased the need for improved water management and wastewater minimization. Adopting techniques to minimize water usage can effectively reduce both the demand for freshwater and the amount of effluents generated by the industry. In addition to this environmental benefit, efficient water management reduces the costs for acquiring freshwater and treating effluents.

This session provides a platform for development of modern technologies for energy and water efficiency and for exchanging ideas in the field. They include, beside the others, the Process Integration and optimisation methodologies and their application to improving the energy and water efficiency of mainly industrial but also nonindustrial users. An additional aim is to evaluate how these methodologies can be adapted to include the integration of waste and renewable energy sources for energy conversion and water supply/purification. The session is outlining the field of energy and water efficiency, including its scope, actors, and main features. The deals with energy and water saving techniques. An increasingly prominent issue is assessing and minimizing emissions and the the environmental footprints: carbon and water footprints. The carbon footprint (CFP) is defined by the U.K. Parliamentary Office for Science and Technology as the total amount of CO2 and the other greenhouse gases emitted over the full life cycle of a process or product. IN a similar way the water footprint

embodies the various water quantities used for the manufacturing and delivery of a product. For energy supply, there have been numerous studies that emphasize the "carbon neutrality" of renewable sources of energy. However, even renewable energy sources make some contribution to the overall carbon footprint, and assessment studies frequently do not account for this. The carbon footprint should also be incorporated into any product life-cycle assessment (LCA).

Session organizers
***Dr. Petar Varbanov**, University of Pannonia, Veszprém, Hungary*
***Prof. Jiří Jaromír Klemeš**, University of Pannonia, Veszprém, Hungary*

Dr Varbanov worked for the Institute of Chemical Engineering, Bulgarian Academy of Sciences, where he still acts as a Consultant. After a spell in the industry in Bulgaria he got a scholarship at a prestigious British University – UMIST, Manchester. He got PhD in Process Integration from UMIST with distinction and won another prestigious EC Marie Curie grant for 2-year research at Technische Universität Berlin, followed by another EC grant for coming to the University of Pannonia - Hungary, where he is a Deputy Head of the Centre for Process Integration and Intensification CPI2. His experience covers energy saving, water and waste water minimization, optimization of energy supply networks, Systems Modelling, Process Synthesis and Process Operation. His research has been successfully implemented in collaboration with industrial partners: BP-Coryton, BP-Grangemouth, MOL Százhalombatta. Presently he has been contributing to 7 EC co-funded research projects. He has published more than 50 papers in peer-reviewed journals. He is a co-author of two books and several chapters in books. Dr Varbanov acts as a scientific secretary of the PRES series of conferences and editor of the related Special Issues in respected journals such as Applied Thermal Engineering, Journal of Cleaner Production, Cleaner Technologies and Environmental Policy, Theoretical Foundations of Chemical Engineering.

Prof Dr Jiří Jaromír Klemeš,DSc - Pólya Professor, the Head of Centre for Process Integration and Intensification CPI2 at the University of Pannonia, Research Institute of Chemical and Process Engineering, Faculty of Information Technology, Veszprém, Hungary. Previously the Project Director and Hon Reader at Dpt of Process Integration at UMIST and The University of Manchester, UK. Research in neural network applications at University of Edinburgh, Scotland. Comprehensive industrial experience, process integration, sustainable technologies and renewable energy. Successful industrial applications. Track record of managing 73 major European and UK Know-How projects and consulted on energy saving and pollution reduction. Overall research funding attracted over 10 M€. Editor-in-Chief of Chemical Engineering Transactions, Subject Editor of ENERGY and Journal of Cleaner Production, Regional Editor for Europe of Applied Thermal Engineering. Editor of Cleaner Technologies and Environmental Policies; Resources, Conservation and Recycling; Theoretical Foundation of Chemical Engineering

and several other journals. In 1998 founded and is the President of International Conference Process Integration, Mathematical Modelling and Optimisation for Energy Saving and Pollution reduction - PRES (www.conferencepres.com). An Acting Chair of CAPE WP (Computer Aided Process Engineering) of European Federation of Chemical Engineering.

SDWS2012.0328 Increasing Economic Potential for Process Heat Recovery by Optimising Hen Designs Over a Full Lifetime

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Abstract

A reduction in utility consumption is required, in order to obtain a sustainable process system. There are various ways of increasing the utilisation of heat that would otherwise be wasted. An important potential for the reduction of energy consumption in process systems relates to heat recovery by applying process integration methodology. One option for stimulating the utilisation of heat is by increasing the prices, the introduction of taxes and/or subsidies. However, reducing costs using energy recovery from the beneficial designs of HENs over processes lifetimes would be both environmentally friendly (reducing the emissions and pollution), and economically more attractive. More economical designs could be obtained by establishing appropriate trade-off between the investment and operating cost. The extent of heat recovery is naturally constrained by the economy: when the utility price increases, the limit of recuperation also increases. For an optimal HEN design the utility cost coefficients should correctly reflect the future variability and even unpredictability of the utility prices. The objective of this work was to optimise HEN designs for full process lifetimes, by assuming future reality utility cost coefficients, as closely as possible.

To date, most optimisation models for HEN synthesis have been single-period optimisation models. They are suitable for non-fluctuating utility prices, usually current prices only. Those models where the objective is to minimise the total annual cost for fixed energy costs, do truly reflects the trade-off for several reasons: (i) the utility prices traditionally fluctuate; (ii) the annualised investment varies with any change of the HEN lifetime, and (iii) the value of money is usually not fully considered during optimisation.

A multi-period mixed-integer nonlinear programming (MINLP) model for HEN synthesis with the cost coefficients forecasted for full processes lifetimes has been developed in order to consider these variations. Different projections regarding utility prices have been derived, based on the past utility prices, due to the uncertainty of forecasting. A stochastic approach was applied, where all possible utility price scenarios were considered. Each has its own set of probabilities varying over a lifetime. The maximisation of Incremental Expected Net Present Value was selected as an optimisation criterion in order to consider any future fluctuations in utility prices, and time value of money over a full lifetime.

The results from these optimisation yield optimal HEN designs reflect all the different utility price realisations over a full process lifetime. Several examples were studied in order to compare results between the novel stochastic multi-period MINLP model and the conventional single-period models.

SDWS2012.0033 A Novel Optimization Approach of Improving Energy Recovery in Retrofitting Heat Exchanger Network with Exchanger Details

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Abstract

The retrofit of heat exchanger network (HEN) has recently being received greater attention both from academic and industrial communities. Improved heat recovery for the existing chemical processes can be achieved through various retrofit techniques, including the facilitation of intensified heat transfer, adding additional heat transfer area, the installation of a new exchanger, and reconfiguration of heat recovery structure (e.g. repiping). Although various mathematical programming methodologies have been proposed for HEN retrofit, most of works are based on large-size complex MINLP models, which are often not readily applicable for retrofit, because there are numerical difficulties related to nonlinearity, problem size and computational time for the optimization of industrial-scale design problem. Most importantly, multiple tube passes and shell passes are widely used for conventional shell-and-tube heat exchangers. In multi-pass types, the flow pattern includes both counter and co-current flow, thus the mean temperature difference is not equal to the logarithmic mean temperature difference (LMTD), and the correction factor of (FT) is proposed to be computed analytically, which is rarely considered before.

Distinct from most of existing works on HEN retrofit, this paper presents a novel optimization method for dealing with the HEN retrofit in which the details of heat exchangers (tube-passes, shell-passes, intensification, LMTD and FT) are systematically identified under given objective function and topological constraints in the existing heat recovery systems. Based on the recent works on retrofit scenarios without network topology modification (Wang et al, 2011; Pan et al, 2011a; Pan et al, 2011b; Pan et al, 2012), an efficient optimization framework, consisting of a simple mixed integer linear programming (MILP) model and two iteration loops, is developed to deal with the computational difficulties associated with the nonlinearity of LMTD and FT. Case study based on literature examples are carried out to demonstrate the validity and soundness of the proposed approach, showing that the new proposed approach is able to provide realistic and practical solutions for debottlenecking of HEN with systematic consideration of exchanger details.

SDWS2012.0248 Principles for Sustainability in Modern State-Building for Efficient Energy and Water Supply

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Abstract

Modern state-building missions, such as the ones carried out by the International Community in Iraq and Afghanistan, have paid little attention to creating the conditions required for sustainability and environmental protection. The issues of building or restoring water and energy supply infrastructures, minimising the waste disposal, energy cost and harmful emissions to the environment, are frequently the most critical ones. This has simply not been made possible by the state-building model applied so far, which is based on the intensive use of military force to eliminate the harmful political regime ruling a given country. The author has discussed in one of his earlier publications that developments in the field of information and telecommunication technology (ITC), and the Internet provides new opportunities for the International Community to intervene in processes taking place in failed states. As a result, the role, nature and contents of the application of hard power changes as well.

One of the new opportunities available to the International Community is to create a virtual economic zone above the state to be re-built, thereby providing qualitatively new infrastructural conditions for social and economic development. Based on these

conditions, it becomes possible to focus on laying down the foundations required for sustainable development and to satisfy the basic needs of the population, such as the need for stable water and energy supply. All that requires radical changes in current financial aid delivery practices and in the provision of scientific and technological help.

The research work conducted to create a theoretical and methodological background to support such changes takes place within the framework of a complex K+F project designed to develop a model for the above mentioned virtual economic zone. One of the main aims of this project is "to create the foundations required for sustainability under extreme security, political and economic conditions". The most important question is how integrate the best practices used in the world to ensure sustainability in the operation of a virtual economic zone created and functioning under extreme conditions. The presentation summarizes the first results of the research conducted to answer the above question, discussing the main principles of sustainability which should be followed during the development of aid delivery practices and the creation and development of a virtual economic zone.

SDWS2012.0247 Improved Targeting of Industrial Total Sites Accounting for Different Heat Transfer Properties

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Abstract

The paper deals with an extension of Total Site Integration (Klemeš et al., 1997) to Locally Integrated Energy Sectors (Perry et al., 2008) producing more realistic utility and heat recovery targets. Process Heat Integration (based on Pinch Analysis) aims to minimise the amount of energy mostly used in industrial processes. Recently, a procedure modification for Total Site Targeting has been developed (Varbanov et al., 2011) to handle cases when different values for the minimum allowed temperature differences (ΔT_{min}) are specified for each process on the site. This is an improvement over the practice of specifying a single uniform ΔT_{min} for all processes integrated in a Total Site and allows obtaining more realistic heat recovery targets for Total Sites.

The current work provides the next step by applying the new concepts and the modified procedure to several types of Total Sites – including traditional industrial Total Sites, food industry and pulp-and-paper. The targeting results are analysed and compared.

SDWS2012.0055 Calcium Sulphate Fouling in a Batch Stirred Cell

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Abstract

Fouling concerns the formation of unwanted material on heat transfer surfaces. It reduces heat transfer efficiency, undermines heat recovery and creates environmental problems. Mineral scale fouling on heat exchanger surfaces creates a chronic operational problem in a broad range of process plants that include cooling water systems, desalination, and steam generation.

In the current study, a simple batch stirred cell (Young et. al, 2011) has been used for the first time to study the effects of surface shear stress and surface temperature on fouling from saturated calcium sulphate solutions. Different metal surfaces, including those incorporating wires to enhance turbulence and heat transfer, have been used. The results show that the fouling rate on the surface of a probe made of stainless steel is significantly lower than on both mild steel and copper surfaces, even when the stainless steel is used at much higher surface temperatures. The fouling rates on the mild steel and copper surfaces were found to be broadly similar to each other. The overall fouling rate on the mild steel surface was found to be reduced when fine wires were attached to it. This confirms the general effect on fouling by increasing the surface shear stress through surface enhancement. Nonetheless, it could be seen visually that when wires were present the distribution of fouling was non-uniform. Indeed, the greatest amount of fouling appeared downstream of the wires where the surface shear stress was the lowest and the least amount just upstream of the wires where the surface shear stress was the highest. In all cases, the overall fouling resistance increased asymptotically towards a constant value and could be modeled by a simple Kern and Seaton expression.

The actual fouling profiles were obtained visibly and by using a ProScan laser micro-scanning technology. CFD simulations of the fluid flow in the stirred cell (Yang et. al, 2009) with test probes with or without attached wires attached were carried out using the commercial package Comsol 4.2. The resulting velocity, shear stress and temperature fields are presented and show clearly how the experimental effects of temperature and surface shear stress on the fouling are well correlated by the CFD simulations.

SDWS2012.0175 Numerical Investigation of Transport Phenomena in Spiral-Wound Heat Exchangers

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Abstract

Up to now, the design and optimisation of heat exchangers is mainly based on empirical rules and practical experience. A deeper understanding of the fundamental transport phenomena occurring in heat exchangers can help to bring their design and operation closer to the optimum. Within the EU project INTHEAT, a spiral plastic heat exchanger is investigated by the University of Paderborn and Makatec Apparate GmbH (Makatec). The objective is the development and validation of advanced 3-D CFD models to describe the heat exchanger behaviour and predict its functionality. The investigated heat exchanger was developed by Makatec and consists of spiral-wound plastic foils which are kept separated by spacer filaments. Such units are applied in heat transfer operations with chemically aggressive liquids in order to overcome corrosion problems. In this work, a Computational Fluid Dynamics (CFD) model for detailed description of the flow field in the complex spiral plastic heat exchanger geometry is developed. Flow pattern is often crucial for the heat exchanger efficiency. In order to reduce the simulation domain and refine the mesh, a periodic simulation element is identified, which represents just one spacer intersection. The simulations are performed for a single-phase liquid flow and for volumetric flow rates used in the Makatec test rig. The developed model is validated against experimental data provided by Makatec. The simulation studies help to evaluate the influence of the spacer geometry on the flow behaviour. Before the study, it was expected that the spacers would cause turbulent flow which would intensify the heat transfer between the fluids. However, up to now, we have not been able to identify such phenomena in the range of studied flow rates. This can be seen from the interplay of streamlines in Fig. 1. It indicates a low mixing degree which is disadvantageous for the heat transfer. Based on the obtained results, geometry improvements towards enhanced convection have been suggested. The optimised geometry parameters include the angle of the spacer filaments, the thickness of the spacers as well as the number of spacers.

SDWS2012.0354 Energy Saving Processes of Biofuel Production from Fermentation Broth

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Abstract

Bioenergy from renewable resources is already today a viable alternative to fossil fuels; e.g to bioethanol or biobutanol. Bioethanol can be produced from e.g. sugars, starch and various lignocellulosic materials such as straw, wood and waste. High energy consumption is necessary for concentration of the alcohol from the fermentation broth to meet the fuel dryness specification. Although several separation technologies are technically capable of removing volatile products from fermentation broths, distillation remains the dominant technology. This is especially true for the recovery of biofuels such as ethanol or butanol. To reduce this cost the distillation should be integrated with membrane separation not only above the azeotropic concentration but below that point. E.g. the pervaporation can be more efficient separation process than the distillation depending on the membrane separation properties. Other alternative separation processes are e.g. the membrane distillation and the vapor permeation. The main aim of this lecture is to analyze the energy demand of these processes and to investigate how the necessary energy can be reduced. Accordingly, the following processes will be analyzed focusing their energy demand:

- distillation integrated by pervaporation,
- more steps pervaporation,
- membrane distillation,
- vapor permeation.

All these processes will be compared to the energy demand of the distillation process. It will be shown how the membrane properties as separation factor, permeation rate affects the energy consumed during the processes and it will be offered an efficient, alternative separation process for biofuel production.

SDWS2012.0490 Process Integration in Biodiesel Production

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Abstract

Biodiesel is an important biofuel. Some technologies are already developed but innovation is still possible, especially to ensure sustainability of proposed designs. This paper proposes to use a systematic approach for the development of a biodiesel plant flowsheet with final goal to have a sustainable design. As a first step a conceptual, block diagram is developed, and then the resulted scheme is simulated. Specific compounds are generated as pseudo components for simulator library. To improve the energy efficiency of the plant, process integration methodology is applied to exploit process streams potential. SPRINT - heat exchanger network design tool from CPI-Universiy of Manchester is used. A new flowsheet is generated based on heat exchanger network designed in previous step. To evaluate environmental impact WAR algorithm is used. Some alternative designs are ranked considering economic performance and environmental impact.

SDWS2012.0278 The Influence of Plate Corrugations Geometry on Plate Heat Exchanger Performance in Specified Process Conditions

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Abstract

The plate heat exchanger (PHE) is one of the most efficient modern types of heat exchange equipment with enhanced heat transfer. PHE consists of a number of corrugated heat transfer plates stamped from a thin metal. The geometry of plates and corrugations on them determines heat transfer characteristics and hydraulic resistance of inter-plate channels. The influence of plate and its corrugation geometrical parameters on performance of PHE is studied. The mathematical model of PHE is developed using decomposition of the plate on its main corrugated field, which cause major effect on heat

transfer, and distribution zone, which influences mostly the hydraulic performance. Model is validated on experimental data for some commercial plates. The calculations are made to estimate the influence on PHE performance of plate spacing, plate length, the corrugations inclination angle to plate axis and corrugations pitch to height ratio. It is shown, that for specified pressure drop, temperature program and heat load the geometrical parameters of plate and its corrugations, which are enable to make PHE with minimal heat transfer area, can be found. For different heat transfer process conditions the best values of these geometrical parameters significantly varying. It is require designing and manufacturing the plates of different sizes and geometrical form of corrugations, which can better satisfy certain ranges of process conditions. The main geometrical variables for this purpose are plate size and spacing between the plates. To select the best PHE inside the range of conditions the main variable is the corrugation angle to the plate longitudinal axis. The different angles in practice can be simulated by combining two types of plates in one heat exchanger. It is shown that such method gives much better results than varying the passes numbers, which can be employed mostly in conditions that are out of the range, for which the plate is designed originally. The developed mathematical model can be used designing of plates with geometry, which is in the best way satisfying process conditions of the certain specific range. The case study for conditions of PHE application in District Heating systems is presented.

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SDWS2012.0360 Full Scale Plume Rise Modeling in Calm and Low Wind Velocity Conditions

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Abstract

Together with chemical and metallurgical plants, the power stations are among the main sources of air pollution nowadays. Even they are characterized with comparatively high stacks, the amount of pollutants emitted in the atmosphere is significant and hence – serious air pollution episodes may be caused.

A variety of models and software products exist and are in use for computer simulation of pollutant dispersion for air pollution assessment. All of them need to calculate the so called plume effective height, but they meet difficulties in calm and low wind speed conditions.

This investigation is directed to the gas pollutant dispersion in such meteorological situations. Considering sub-adiabatic and near adiabatic conditions, the influence of stack parameters, the temperature gradient of the atmosphere and the surface wind speed in the range from zero to 1.5 m/s is studied. By use of PHOENICS software package a CFD problem has been formulated and solved for planned combinations of meteorological conditions and stack parameters.

For each numerical experiment the height of the plume center line and hence the plume rise has been assessed. The results obtained have been used to work out a mathematical model for plume rise calculation.

SDWS2012.0380 Rescheduling Operations Demands to Increase Solar Energy Utilisation

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Abstract

The efficient management of the renewable energy sources to reduce the consumption of fuels with high impact on the environment (e.g. fossil fuel) is an important prerequisite for sustainable process plants. The problem carries a substantial complexity due to a number of different processing units and the variations on both the supply and demand sides. Besides heat demand occurring at different temperature levels, electricity demands need to be satisfied as well. On the supply side the variations arise from the fluctuating solar irradiations and also its way of utilisation. There are main two ways for solar thermal heat utilisation: (i) direct transfer from the capture system to the process and (ii) indirect transfer from capture system via storage to process. The surplus of energy can be stored and is going to be available for a later utilisation. The storage requires additional investment and maintenance costs and also the temperature of the heat storage and electricity amount for power storage decreases over time.

Some of the operations can be shifted in time and increase by this the amount of energy, which can be used directly, without the need for the storage. The aim of this study is to maximise the direct use of solar energy and minimise the energy storage capacity by rescheduling by formulate an efficient mathematical programming model.

The optimal solution of re-scheduling of flexible operations in time can depend on the design parameters. A retrofit sensitivity analysis where the optimal schedule has been identified for different design conditions has been developed to evaluate this issue.

Examples of time scheduling flexible processes can be found in the food and drink industries (e.g. milling the wheat, making a pasta etc.) and elsewhere in the service sector (washing the laundry). As a consequence the consumption of utilities and consequently the impact on the environment is reduced.

SDWS2012.0153 Water Efficiency Indicators in Croatian Manufacturing: Some Lessons and Policy Implications

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Abstract

The water is vital natural resource. In the same time it has economic and social value.In order to protect and improve the water status in European Union, in 2000 Water Framework Directive (WFD) was formulated. WFD emphasize integral approach in water planning and management with broader implementation of economic instruments. River basin management plan (RBMP) is the main instrument to achieve goals stated in WFD. In the accession process to EU Croatia acquires WFD requirements in national water legislation, including formulation of RBMP until the end of 2011. RBMP covers diverse aspects of water management with special focus on economic analysis of water use. The primary objective of economic analysis is to identify economic sectors that are significantly water-dependant or sectors with high impacts on water status.

The aim of this paper is to perform economic analysis of water use, including water efficiency indicators for the period 2000-2009 at the national level. Manufacturing produces pressures in water status, both in terms of quality and in terms of quantity. Therefore, after introductory remarks, the second section of the paper is focused on economic analyses of water use in selected manufacturing industries (according to

National Classification of Activities 2002 - manufacture of food products and beverages, manufacture of tobacco products, manufacture of chemicals and chemical products, manufacture of rubber and plastic products, manufacture of basic metals, fabricated metal products, machinery and equipment).

The third section deals with water efficiency indicators. To perform economic analysis of water use we need to relate different physical and technical data (volume of water used for production, cooling, sanitation, volume of wastewater, volume of treated wastewater, etc.) with some economic values (GDP, gross value added, turnover, etc.). As in Croatia water efficiency monitoring system has not yet been established and due to limited availability of required data, we propose to use simple but analytically valuable indicators, namely water productivity and water intensity indicator. Water productivity is defined as ratio of produced output in specific industry and volume of water used in this industry. Water intensity measures the intensity of water use in terms of volumes of water per unit of value added. We argue that water productivity and water intensity indicators, although simple, measure economy pressures on water resources and therefore they can serve as proxies for water sustainability metrix. Policy implications of this analysis are also presented.

We conclude this paper by addressing future challenges related to formulation of a new integral framework of water efficiency indicators. Some new issues for research agenda are proposed, too.

SDWS2012.0460 Technical Innovation for Heat Transfer Intensification for Heat Recovery

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Abstract

Retrofitting heat exchanger networks has been widely studied in process industry in the last few decades because people are becoming increasingly concerned about how the energy is utilised and recovered in the existing heat exchanger networks (HENs). Conventional retrofit approaches proposed to improve HEN heat recovery mostly employ adding more exchanger area, installing new exchangers, rearranging heat-recovery matches and repiping streams. Recently, heat transfer intensification has been widely adopted in process industry as an efficient technique for retrofitting HEN. By implementing enhancement techniques for existing exchangers, higher heat transfer coefficients can be achieved, leading to more heat exchange in the existing matches,

therefore the overall energy recovery of HEN can be improved even though no topology modification is considered (Wang et al., 2011; Pan et al., 2011a; Pan et al., 2011b). Heat transfer intensification has practical advantages in HEN retrofit, as it can avoid physical modification of the exchanger itself and be easily implemented with much lower investment cost.

The conventional intensification techniques includes tube-side enhancements (internal tube fins, twisted-tape inserts, coiled-wire inserts, hiTRAN®, etc) and shell-side enhancements (external tube fins, helical baffles, EM baffles®, etc). Commonly, combining several enhancement techniques can achieve more energy saving compared with single technique implementing. Thus, this paper will focus on the performance of tube-side and shell-side enhancement techniques, and investigate their combination to obtain substantial heat recovery in heat exchanger networks.

SDWS2012.0298 A Holistic Process Integration Approach for Regional Carbon Planning from Stationery Point Sources

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Abstract

Power plants, steel plants, cement factories and petroleum refineries of the industrial sector contribute up to 60% of the overall global CO2 emissions. Various process integration techniques have been developed to reduce carbon emissions from such stationery point sources. These include the Carbon Emission Pinch Analysis (CEPA) technique that has been introduced for energy supply planning via optimal allocation of renewable energy sources to meet sectorial or regional energy demands under carbon emission constraints. Earlier applications of Pinch Analysis for have focused on demand-side energy management that integrates energy-efficiency improvement and utilisation of renewable energy to reduce carbon footprint . In planning for a comprehensive and effective carbon emission reduction strategy for a region or a country, there is a need to look at the bigger picture by holistically addressing both energy supply and energy demand sides covering both electricity as well as thermal energy that affect carbon emissions. This work introduces a holistic process integration approach for carbon planning that is centred around a Carbon Management Hierarchy (CMH). The CMH is a framework to guide and prioritise the implementation of carbon reduction strategies to

achieve the minimum regional carbon emissions. The holistic framework begins with carbon demand planning, followed by targeting the maximum carbon exchange using a modified source and demand curves. Next, the CMH is introduced to systematically guide carbon reduction process changes towards the holistic minimum carbon supply as well as emission targets. The hierarchy consists of four levels i.e. (1) Direct reuse, (2) Source and demand manipulations; (3) Regeneration reuse; (4) Carbon sequestration. The regional minimum carbon utilization network is finally designed using the network allocation diagram. The holistic framework has the flexibility to utilise various models as well as heuristics that can lead towards the minimum carbon targets. For example, at level 2 of the CMH, management of the energy supply side may include utilising mathematical approaches for optimal planning of decentralize electricity generation (DEG). On the other hand, demand-side management may include implementation of various established energy efficiency measures for carbon reduction.

SDWS2012.0364 The Logging Waste as Inexhaustible Resource for Alternative Energy

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Abstract

The article shows that during the production and consumption of fuel wood for bioenergy projects in the organization of the Northwest and other regions of Russia there is the problem of lack of raw materials. It is established that the waste timber, during cutting on average, about 20% of the stock of standing timber. This value varies according to region, type forest resources and the skills and technical equipment performer. Therefore, the main purpose of the article - a system evaluation of the use of forest residues in Russia. The authors present data on volumes of raw materials for production of wood chips and pellets on example, the Northwest region of Russia. Only about 30% of wood chips are now receiving from wood waste, and bulk wood chips and pellets produced from the wood of stems. Small volume of use of bark, twigs, branches, tops, stumps and roots is due imperfection processing technologies. Another important issue addressed in the article - the lack of standards and guides taxational inventory valuation and structure of the waste in many regions of Russia. This primarily relates to the hardwood. Our research has shown that, depending on tree species, the structure and volume of waste are significantly different. Expert evaluation conducted by the authors shows that the proportion of forest residues from 5 to 20% of the stock of wood. Found that in different forest types share twigs and branches, and stumps and roots varies considerably according

to species of tree. But even within the forest reserves such as twigs, branches and underground parts of the same species depend strongly on the age of stands and their completeness, and the differences may reach 2 to 5 times the size.

SDWS2012.0362 Potential Maximum C Stores in St. Petersburg Region

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Abstract

These articles presented information on dry organic biomass from permanent plots established in various forest types throughout the St. Petersburg region and similar locations in the administrative regions surrounding the St. Petersburg region.

In the absence of stand replacing disturbance, forest ecosystems eventually approach some maximum carbon stock which depends on site conditions and properties of plant species. Potential maximum C stores in forest ecosystems are an important constraint on predictions of the amount of C that can be added to existing C stores. Globally, forest ecosystems offer significant potential to sequester atmospheric C at modest social costs and a wide array of management measures in land-use and forestry have been evaluated for their effectiveness in reducing CO2 concentrations in the atmosphere, however several issues concerning C sequestration in forest ecosystems remain unresolved. Many of the existing estimates focus on immediate effects of different management practices and leave unanswered the critical questions of the timing, security, and sustainability of these effects. Moreover, these estimates are not explicitly constrained by the carrying capacity of ecosystems and may lead to gross over-estimates if used in long-term projections into the future.

Most of the primary late-successional forests in the St. Petersburg region may be dominated by one of the two major conifer species, Pinussylvestris L. (pine) or Piceaabies (L.) Karst. (spruce). Spruce occurs on sites of medium to high productivity, while pine is the primary species on poor sites, which include dry sandy and rocky soils at one extreme of soil moisture range and poorly drained locations with thick duff or peat layer at the other extreme. Following disturbance the conifer species are often replaced by the natural regeneration of hardwoods, such as birch (Betulapendula) and aspen (Populustremula L.). This process is particularly common on productive sites, where hardwoods have a large competitive advantage.

The carbon pools that were measured or estimated are described below, a biomass-to-C ratio of 2:1 was used in all calculations.

The maximum potential store of organic matter in live vegetation of tree stands in the St. Petersburg region is 981.8 million tones. Using 2:1 ratio of biomass to carbon, the carbon store will be 490.9 million tones.

SDWS2012.0462 Estimating Benefits of Heat Transfer Enhancement in Hen Design

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Abstract

Heat transfer enhancement is one of the most promising methods to minimise the size and weight of heat transfer equipment and at the same time to increase heat recovery in industrial processes. It reduces the environmental footprint of industrial process units, minimizes their energy consumption and carbon dioxide emissions. But the principles of the construction and correlations for design of enhanced heat exchanger (HE) generally substantially differ from those for conventional shell-and tube HEs. For tubular HEs those principles are regulated by standards of Tubular Exchangers Manufacturers Association (TEMA), correlations for at least approximate thermal and hydraulic design can be found in open literature, open source and commercial software available. For enhanced HEs such information is much more limited and proprietory. Plate Heat Exchanger (PHE) is one of established types of enhanced HEs. To estimate the possible benefits of that kind of heat transfer enhancement the mathematical model of PHE accounting for plates and their corrugations geometry is used. Based on this model the optimization algorithm is developed using MINLP method with inequality constraints. The objective function is PHE heat transfer area. Optimizing variables are plate spacing, plate length, the corrugations inclination angle to plate axis and corrugations pitch to height ratio. The resulting optimal solution can be regarded as a target for PHE heat transfer area, when the geometrical parameters of plate and its corrugation strictly correspond calculated optimal values. The algorithm is implemented as DLL module, which can be used for multiple calculations when optimizing heat exchanger network (HEN). In that case the procedure of optimal HEN development is stepwise, using retrofit strategy described in literature. In the first step the initial HEN structure is developed with conventional tubular HEs using methodology of pinch analysis and process integration. After that the matches and streams, where conditions are suitable for the use PHEs, are identified. For these positions the obtained values of heat transfer coefficients and cost functions of PHEs are taken.

With these values new optimization steps should be made until obtaining final optimal solution. It is shown that the use of enhanced PHEs is widening the space of possible HENs options and can lead to better global optimum. Other factors are accounting for possible heat transfer enhancement in tubular heat exchangers and mitigation of fouling on enhanced heat transfer surfaces, which are the further research topics.

Acknowledgement The support of EC Project INTHEAT (contract № FP7-SME-2010-1-262205) is sincerely acknowledged.

SDWS2012.0555 The Potential of Total Site Process Integration and Optimisation for Energy Saving and Pollution Reduction

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Abstract

This contribution highlights the potential improvements of Total Site methodology for enabling its wider application within industry, as well as for the integration of renewable energy sources. One of the important extensions would be its ability to handle any fluctuations in energy supply, and the demand for exploiting appropriate heat storage as a degree of freedom. Other important issues that would be tackled are: (i) Integration of heat transfer area targets and different ΔT_{min} specifications for each process, and for heat exchange between utilities and processes; (ii) Fouling, heat transfer reduction/intensification; (iii) Piping costs for Total Site integration; (iv) Pressure drop/investment and running costs of pumps; (v) Single (economic) and multi-criteria optimisation (economic and environmental evaluations) of Total Site systems. Advancing those design and operation practices accounting for these issues could considerably contribute to energy saving and pollution reduction, as Total Sites are huge consumers of both energy and water within processing industries, as well as for Locally Integrated Energy Sectors. Any reductions in energy consumption would also contribute to reductions in emissions and pollution.

SDWS2012.0378 Simultaneous Optimization Model for the Synthesis of Heat-Integrated Process Water Networks

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Abstract

This contribution describes the development of simultaneous optimization model for the synthesis of heat integrated process water networks. The recently proposed water network model by Ahmetović and Grossmann (2011) is now extended for both direct and indirect heat exchange and combined with the heat exchanger network (HEN) model introduced by Yee et al. (1990). Connection between the models is achieved by interconnecting hot and cold streams. Hot and cold streams from the water network are cooled and heated in the heat exchanger network and returned to the water network satisfying temperatures of process units and temperature of discharged wastewater stream. Although many temperatures of these streams are known, there are certain streams, i.e. after mixing points, which temperatures are optimization variables and thus unknown. For most of these streams it is impossible to determine should they in HEN be characterized as hot or cold stream. To circumvent the problem, each stream is represented by a set of hot, cold and by-pass stream, and described with convex hull formulation for the identification of its role in the HEN. Based on this formulation and connecting constraints the heat integrated process water network model can be solved. The objective is to synthesize the network with minimal total annual costs. The overall model proposed is formulated as a nonconvex mixed integer nonlinear programming (MINLP) problem with additional 0-1 variables included for the identification of the streams. The proposed model is tested on several literature examples using available solvers from the GAMS library. The resulted networks exhibit similar or smaller total annual costs with similar or smaller consumption of freshwater and utilities as reported in the literature.

SDWS2012.0491 Carbon Dioxide Capture by Microalgae in a Photobioreactor : Sustainable Process Development

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Abstract

Capture of carbon dioxide (CO2) from fossil fuel power plants, and capture is of main concern for reducing global warming. Among numerous techniques it seems to be promising large scale cultivation of microalgae for fuel gas CO2 fixation. With sunlight, water, minerals and of course CO2, microalgae growth in photobioreactors obtaining desired products as biodiesel. The objective of this paper is to design a sustainable process for flue gas CO2 capture and production of biodiesel from algal oil, in alkaline solutions of microalgae. To ensure the objective some methodologies and computer tools were used : process simulator SuperProDesigner, process integration software STAR and environmental impact evaluation WAR. A systematic approach to process development was used. As a first step a general scheme was considered, then process simulation and analysis was based on SuperProDesigner simulations. Process integration approach was used to ensure rational use of energy and water. Cost analysis and environmental impact evaluation ensured sustainability performance of the process. Validation was based on experiments at laboratory scale with microalgae strain ensuring CO2 biofixation and biodiesel synthesis. A preliminary evaluation, shown that the yield of CO2 biofixation by microalgae was about 25%.

SDWS2012.0307 Optimal Renewable Energy Systems for Regions

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Abstract

Most sources for renewable energy can be deduced from solar radiation as the main natural income of society. Contrary to conventional fossil and radioactive energy resources that are mined or pumped out from central point sources, solar energy is a de-central resource that requires area for its conversion to useful products and services. This

requires a new technological as well as logistical concept for energy systems where regions play a key role as providers of energy and goods.

The contribution will provide the conceptual framework for renewable energy system generation on a regional level, taking into account the responsibility of regions to provide goods and services to the larger society and to support urban centres. It will show how optimal resource-technology-demand networks may be constructed, using process network synthesis approaches (using the P-Graph method[1], [2] and how the ecological efficiency of such regional systems can be measured using the Sustainable Process Index[3],[4].

Application of these methods to real life case studies (in particular the region of Mühlviertel in Austria) will on the one hand prove the versatility of the methods presented and on the other hand will provide insight into the scope of necessary change if society moves towards a low carbon sustainable energy system.

SDWS2012.0043 Modelling Energy Demand of Croatian Industry Sector

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Abstract

Industry represents one of the most interesting sectors when analyzing Croatian final energy demand. As shown through past energy balances, energy consumption of Croatian industry sector had mild yearly increases for the last fifteen years, after the consumption was halved in the beginning of 1990s. Croatian industry presents 20% of nation's GDP and employs 25% of total labour force making it a significant subject for the economy. Today, with around 60 PJ of finale energy demand it is the third most energy intensive sector in Croatia, right after transport and households. Considering this consumption, implementing different mechanisms that would lead to improvements in energy efficiency in this sector seems relevant. In order to plan future energy systems it is important to know what are future possibilities and needs regarding energy demand for different sectors. Through this paper long term energy demand projections for Croatian industry sector will be shown with a special emphasis on different mechanisms, both financial, legal but also technological that will influence future energy demand scenarios. It is important to see how these mechanisms influence, positive or negative, on future energy demand and which mechanism would be most influential. Energy demand predictions in this paper are based upon bottom-up approach model which combines and process large

number of input data. The Model will be compared to Croatian National Energy Strategy and certain difference will be presented. One of the major conclusions shown in this paper is significant possibilities for energy efficiency improvements and lower energy demand in the future, based on careful and rational energy planning. Different financial, legal and technological mechanisms can lead to significant savings in the industry sector which also leads to lesser greenhouse gas emissions and lower Croatian dependence on foreign fossil fuels.

SDWS2012.0226 Environmental Analysis of the Phase Change Materials (PCM) to Improve Building Energy Performance

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Abstract

The direct and indirect environmental impact of the building industry in Europe and Spain (throughout a whole life cycle) indicates that between 33% and 42% of primary energy consumption, half of which is for Heating, Ventilating, and Air Conditioning (HVAC), is absorbed by this sector. According to updated data from the Environmental Indicators Public Bank of the Ministry of Environment, the energy consumption in the building industry in 2005 reached 18,123 ktep (1.12 tep/home versus EU 1.7 tep/home as the lowest heating consumption, even though the Spanish growth rate is higher than Europe's). This represents 17% of national energy consumption and shows that an 11.2% average annual raise has been taking place since 2000, meaning that annual emissions have reached 19,438.9 kt CO2.

Phase Change Materials (PCMs) can passively cool and heat a living area without the need of including heavy mass or extra space typically required by sensible heat storage materials. It has been demonstrated that for the development of a latent heat storage system (LHTS) in a building fabric, the choice of the phase change material (PCM) is key to improve the heat transfer mechanism in the building. They can be incorporated in the walls, ceiling and floor of buildings for further thermal energy storage and will help in reducing energy demands associated with temperature control. The potential for PCMs is great. For example, converting 0.45 kg of ice at 0°C to 0.45 kg of water at 0 °C requires the "storage" of about 1.055 MJ, conversely, about 1,000 Btu are released as the water

freezes. A temperature change of 5/9°C requires about 1.42 m^3 (3,175.75 kg) of concrete to store 1.055 MJ. The reduction in mass and volume offered by PCM use is potentially enormous. However, what is the payback time, in terms of carbon emissions, to recoup any initial carbon investment by PCM incorporation? and what is the overall environmental performance over their lifecycle operation? are specific issues to require additional efforts.

To this end, this research develops a life cycle assessment to determine if energy savings are large enough to balance the environmental impact originated during the PCM manufacturing. Inputs and outputs of each management stage have been defined, and the inventory emissions calculated by SIMAPRO v 7.2 have been classified into impact categories; non- energy sources, final solid waste as hazardous and non-hazardous, global warming and human toxicity. Different PCM types, which are evaluated using different Spanish weather conditions, are studied in order to explore a wide range of conditions. As preliminary result, the use of PCM can reduce the overall impact by more than 12,5 %.

SDWS2012.0085 Oil Palm Biomass Corridor to Promote Malaysia Green Economy

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Abstract

As one of the main exporters and producers of oil palm in the world, the total oil palm planted area in Malaysia reaches 4.98 million hectare as of year September 2011 (MPOB, 2011). Based on the projection of Agensi Inovasi Malaysia (2011), the oil palm industry would provide 12 million tonnes per year by year 2020. Through the oil palm processing, various types of oil palm biomass are producted, which include empty fruint brunches (EFB), mesocape fiber, palm kernel shell (PKS), palm oil mill effluent (POME), etc. As reported by Malaysia Palm Oil Board (MPOB, 2011), 0.23 tonnes of EFB, 0.13 tonnes of mesocape fiber, 0.06 tonnes of PKS and 0.6 tonnes of POME are produced per tonnes of fresh fruit bunch processed. Based on 83.92 million tonnes FFB processed in 2010, the

production of EFB, mesocape fiber, PKS and POME are given as 19.30, 10.90, 5.04 and 50.35 million tonnes respectively. Those biomasses are having huge potential to be used as raw material source drive towards a GREEN Economy. In order to promote the Green Economy, Malaysia should identify and invest in its specific role and leadership position in sustainable palm oil production and fully utilise the green resources (oil palm biomasses) through innovation and generate new wealth for the economy. The concept of "waste-to-wealth" would add further value and sustainability to a critical existing economic activity within the oil palm industry. The main objective of this work is to propose a new concept: Palm Biomass Corridor (PBC) to create a win-win situation for all players in these activities, which include palm oil and other industries. In addition, these activities will also able to expand the oil palm value chain as well as reduce the environment impact. The main features of PBC is to (i) design a supply chain network to linked up all of the potential oil palm processing facilities (palm oil mill and refinery) with biomass processing complex (ii) synthesis a sustainable biomass processing complex which includes biomass pretreatment and hydrolysis, separation, fermentation, chemical catalysis, as well as other technologies and products that is economical feasible, but not yet explored and implemented by Malaysian players. This paper will demonstrate the concept of PBC with a simplified West-Malaysia case study. A two-stage optimisation strategy is proposed to solve two-layer green strategies which integrate oil palm biomass and other waste-sources into Malaysia Green Economy. The macro-layer will focus on the overall supply and delivery of biomass. In this stage, a zone clustering and hub selection based on industry symbiosis approach will be presented. Meanwhile, the micro-layer will stress on the synthesis of biomass processing complex for the production of value-added products.

Panel: The energy security of Southeast Europe – the role of coal

SDWS2012.0579 The Energy Security of Southeast Europe - the Role of Coal / Panel Discussion

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Abstract

What is coming first on your mind when you hear the word: **Coal**? 19th century, industrial revolution, black-faced and tired miners, underground mining catastrophes, black and dirty pieces of stone, maybe some art picture? Or maybe CO2, ozone layer, pollutions, carbon credits? Whatever you might have in your mind, it is true. Coal is still one of the most favorable steady, sustainable and commercially desirable primary sources of energy in the world. Many countries in the world (USA, Australia, Germany, Russia, China, India, Turkey, Poland, Czech Republic), or even our regional countries (Bulgaria, Greece, Serbia, Macedonia, Kosovo, Bosnia & Herzegovina), still strongly depend on utilization of the coal (anthracite, black or brown coal, or lignite) as the primary energy resource.

Although recently coal has been considered (and openly condemned) as the most environmentally unfriendly (un-clean) energy resource, still, even today coal plays a significant positive role in the energy sector worldwide. According to the amount of money that are spent, and research efforts that worldwide are going on to provide the so-called BAT, clean coal movement, CCS facilities, etc., it is obvious that the era of coal is far from ending. Even, very far from declining!

The lignite is the crucial and most valuable energy resource in Macedonia. More than 80% of all produced electricity in the country comes from burning lignite. The two major lignite mines, Suvodol in Bitola and Oslomej yearly provide approximately 7.5 million tones of lignite that is used in the TPPs Bitola and Oslomej.

JSC ELEM considers the investment in opening and excavation of new lignite deposits in the present and new lignite mines, of a paramount importance for stable and sustainable electricity generation to supply customers under most favorable economical parameters in a short and middle term. Lignite is the only fossil fuel which is available in Macedonia, therefore, future exploration and exploitation of the lignite for electricity production has not only economical value, but in general, it has a strategic importance and could provide sustainable development of the entire energy sector and accordingly the economic development of the country.

According to the present status of geological surveys that have been carried out, Macedonia with present rate of utilization of existing lignite mines and opening of some new and already surveyed lignite deposits could count for stable supply of lignite to the existing TPP and potentially with construction of additional TPP with capacity up to 300 MW, for the next 25-30 years. However, since this strategy requires significant investments, there should be a consistent policy towards modernization of the existing lignite mines and TPP and opening of new (open-pit and/or underground) lignite mines and respectively new TPPs if we need "bright" electricity future.

SDWS2012.0595 Electricity from Lignite in the South-East Europe

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Abstract

The lignite is the coal of the lowest quality but its consumption for the electricity production in large thermal power plats is efficient and economical. The electricity production in most countries in the region of the South-East Europe is based on domestic lignite, which provides low cost electricity and security in energy supply. The requirements for the environmental protection and the minimization of production costs impose a competition of lignite with other energy sources: renewables, natural gas and nuclear. Regarding current state-of-the-art of technology for electricity production from lignite in South-East Europe countries and imposed environmental requirements in the near future, the paper presents and discusses the main issues that might have the dominant influence on the role of lignite in energy systems of the region. An overview of estimates for the electricity consumption in the region is presented with expected energy mix for electricity production from indigenous resources and imported energy. The need for the revitalization and efficiency improvement of the current thermal power plants is addressed, together with the installation of plants for the flue gases desulphurization in order to meet EU directives. The necessary increase of installed capacity by building new thermal power plants based on advanced high efficiency technologies, as well as upgrading of existing plants is analyzed in order to meet increased electricity consumption. The competitiveness of the electricity production from lignite is compared with other energy sources and related technologies for electricity production. The new energy market and economy conditions are discussed regarding the requirements for the carbon emission reduction and implementation of new technologies for carbon capture and storage, which inevitably leads to substantial reductions in the plant efficiencies and increased electricity production costs. Availability of lignite resources in the region for electricity production is estimated.

SDWS2012.0599 Integration of Coal Fired Power Plants in Renewable Power Systems

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Abstract

"Increased penetration of RES" is a new paradigm which redefines role and position of fossil, and especially coal, fired power plants in power systems. High intermittency of wind and solar energy imposes requirement for the improvement of the operational flexibility of many existing and all future power plants. Better operational flexibility means more and faster start-ups during the lifetime and higher ramping rates and usually brings decrease of annual operating hours followed by decrease in operating efficiency. Demands on increased operational flexibility should be met as far as possible without reducing the plant's life time due to excessive thermal stress in the material of critical components, such as turbine casing and runner, steam ducts and headers and various thick walled vessels.

Following reports on expected changes of conventional plant role in developed EU countries the lecture would try to forecast implication of future RES development on operating patterns of regional conventional power plants. Particular attention will be paid to thermal stress evaluation systems integrated into plant control systems in order impose constraints on rates of temperature changes during transient operating regimes.

SDWS2012.0567 Coal and Renewables: Their Role in Germany

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Abstract

For the introduction to the panel discussion I will prepare a short introduction on the "coal country Germany" and the way out (?) of coal and inside renewable power technologies.

Among others the topics addressed are:

- hard coal from 100% to almost 0 %

- lignite still a 100% domestic resource

- increase of renewable power genartion from 5% to 20% within 10 years

- jobs lost in old economy and new jobs created in new economy

SDWS2012.0601 Coal Power in Kosovo - Where Are the Limits of Sustainability?

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Abstract

There are ongoing plans in Kosovo to extend the country's lignite-mining operations and install new high capacity power plants. This will have an inevitably negative environmental impact. Bearing in mind the toll that existing power plants have taken on the environment, the planned installation of new capacity must go hand-in-hand with efforts to improve the current environmental situation. The exploitation of lignite is a capital-intensive undertaking, and – beyond its environmental impact – exacts a heavy price in terms of land use, demographic movements, settlement relocation, water consumption, and damage to agricultural sector

It is self-evident that Kosovo cannot build a bright future without developing its energy sector. As Kosovo is rich in lignite, it is only natural that the country rely on this resource for its future development. There are to many issues that render the intensive coal exploitation projects an unwise, unsafe, and unsustainable approach to the development of Kosovo's energy sector.

Kosovo is a too small a country to absorb additional lignite-exploitation capacities without visibly endangering its living environment. Limitations on the country's future development include its: i) high population density, ii) limited water resources, and iii) dropping ratio of arable land per capita.

Existing power plants Kosovo A and B are enormous pollutants, especially with regard to the emission of airborne dust particles. These emissions are 4 (Kosovo B) and 40 (Kosovo A) times higher than EU limits. Regardless of the technology employed at Kosovo C, the increase in cumulative emission levels will significantly reduce air quality.

The opening of the opencast mine in Sibovc and the construction of the New Power Plant will alienate a large expanse of arable land and will visibly reduce the land available for

the further development of existing settlements. Relocation of settlements is an expensive task, and Kosovo is limited in both funds and space. Relocating settlements on revitalized ash dumps is not an option here.

Current studies show that a shortage of water will be the most significant limiting factor on Kosovo's long-term development. The proposed location for the new power plant is already set to suffer most from this water deficit. The region is home to almost all of Kosovo's largest industrial facilities (KEK, Trepça, Ferronikel and many others). Not only do the power plants and mines consume vast amounts of water; they also disrupt the flow of existing river.

Air pollution from power plants presents serious risks to the population's health. Problems commonly attributed to air pollution include asthma, respiratory disease, strokes and early death. Numerous studies have shown that tens of thousands die prematurely as a result of air pollution, while hundreds of thousands develop asthma.

Panel: Academia – industry collaboration in sustainable developement

SDWS2012.0569 Sustainable Materialization of Residues from Thermal Processes into Products - Smart-Pro²

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Abstract

SMaRT-Pro² is an Industrial Knowledge Platform on the Sustainable Materialization of Residues from Thermal Processes into Products. It consists of three research institutions and more than 25 partners from industry, government and civil society. The Platform brings together expertise from chemical technology, materials and metallurgical engineering, civil engineering and building technology, applied mineralogy, economy, organization psychology and law. As such it is able to consider the whole implementation chain of sustainable valorization of waste materials, in particular solid residues and carbon dioxide, the two largest and most important waste products from thermal processes. This Knowledge Platform focuses on different types of waste-to-product valorization such as the production of a carbon sink, construction materials, and sorbents. Thermal processes constitute a bulk activity in metals production, waste incineration, glass industry, etc. They generally produce major amounts of solid waste materials, such as slag and fly ash. Rising prices of raw materials and growing awareness for environmental issues lead to a change in perception of these materials from waste to a potential product. However, this trend is still hampered by various barriers: unreliable low-cost technologies, uncertain and inferior quality of the material, underdeveloped legislation and markets for the resulting products, and poor societal experience with closing material cycles. Thermal processes also generate a vast amount of carbon dioxide which they emit into the atmosphere. The discussion concerning carbon dioxide is evolving rapidly, but it is clear that the emission of this greenhouse gas will become ever more regulated in the future. Limiting net carbon dioxide emissions will in this regard constitute a financial benefit for industry. Sustainable use of solid residues and carbon dioxide, the two largest and most important waste products from thermal processes, is an urgent issue both for the industry involved and society as a whole, considering the financial and environmental repercussions of their production. This Knowledge Platform aims at valorizing solid materials and/or carbon dioxide in high-value products by intensified processes and with clear prospects on the economic and legislative feasibility, ecological benefits and societal relevance. The generic goal of the Knowledge Platform is to strengthen knowledge on valorization of inorganic industrial by-products and provide a

formal platform that can enhance the closing of industrial material cycles in Flanders and abroad.

SDWS2012.0585 Development of a New Accelerator and its Surrounding Applications for Sustainable Future

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Abstract

One example of academia – industry collaboration on developing a new accelerator in Japan will be introduced here.

<Sustainable Development and "Accelerator">

Requirements from sustainable society are (1) low-carbon energy, (2) low-carbon transportation, (3) Medicine, (4) Healthiness of social infrastructure, (5) Safety of society etc. Accelerator has been applied for fundamental science by using high-energy charged particle. Its improvement expands its applications to many practical fields. Recently, a venture company has newly developed more efficient, more stable, and much cheaper accelerators by employing the latest electronic technologies. On-going examples under academia – industry collaboration corresponding to above cases are as below;

(3) Medicine (producing Mo-99): Quan Japan (Venture) – Faculty of Medicine, Osaka University (Academia) – Kawasaki Heavy Industry (Industry)

(4) Healthiness of social infrastructure (Non-destructive inspection of roadways): Quan Japan (Venture) – School of Engineering, Osaka University (Academia) – NEXCO West (Industry)

The reason why these examples are proceeding is that these applications bring the rapid start-up of businesses, because of established relating technologies such as producing process of Mo-99 and neutron-radiography. This reduces risks in business for industrial partners.

It is not yet completed but is considered to make collaboration with Ministry of Defence for (5) Safety of society by applying accelerator for the remote explosive sensing, such as landmine detection, car bomb detection, road-side bomb detection, and so on. Collaborative partners are looked for to (1) low-carbon energy by accelerator driven subcritical reactor system.

<Practical Example>

The most preceding case is to apply accelerator for Mo-99 production. Quan Japan was established in June, 2011. They made collaboration with Osaka University in November, 2011. Their collaboration could obtain financial support for promoting venture in March, 2012. They are now constructing factory in Iwaki-city nearby **Fukushima-Daiichi**. Completion of the factory is planned for October, 2013. Samples of Mo-99 will be shipped in April, 2014.

The dominant reasons of such a rapid progress of academia – industry collaboration in this case are (i) the venture's social trust (owning patent), (ii) understanding of importance of venture by Osaka University and (iii) their clear business model.

<Subject and Forecast of Academia – Industry Collaboration>

Sustainable development requires innovative technologies and ideas. In addition, these have to be implemented as soon as possible. New technology often becomes a threat for existing technology of industry. It is necessary for success of academia – industry collaboration to understand this kind of demerit, importance of new technology creating new business model for giving merit to industry at the same time.

SDWS2012.0586 Academia – a Forest Machine Industry Collaboration in Sustainable Energy Production

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Abstract

The Academia, a forest machine industry collaboration, has been a cornerstone of innovation for sustainable energy production in the forest sector. The approach has been a significant means of achieving economic growth to Joensuu, one of two East Finnish university towns of approximately 73 500 inhabitants that is located near the Finland-Russia border and approximately 430 kilometers from Finland's capital city, Helsinki. Over 70 per cent of the world's high-tech forest harvesters are made in Eastern Finland for energy wood harvesting of renewable forests. Annually, over 1000 harvesters are manufactured in John Deere's machine factory in Joensuu. The amount comprises one third of the total amount of known annual harvester manufacture. A harvester costs from 300 000 to 400 000 euros. Therefore we, the collaborators, regard the activities as significant green business turnover to the region and Joensuu is now a globally recognized

brand among wood procurement professionals. Additionally, the Joensuu region is the Finnish center of the Nordic forest machine cluster.

This green business collaboration between scientists and forest machine industry experts has been built over the past 20 years. In the beginning, we established a common vision for roundwood harvesting named as “the cut-to-length working method and single-grip harvester”. During the second decade of the collaboration, the second vision was developed for energy wood harvesting named as “the multiple-tree processing and grapple scale measurement”. In our opinion, setting a clear vision is important for successful agreement on missions. Clear vision also facilitates the building of sustainable relationships, streamlining the access to capabilities and connecting people and skills in the forest machine production industry. In practice, academic scientists are co-running industrial projects and experts from industry participate in research projects. Project funding has not been necessary for achieving high level research work. To a great extent, active and trustful relationships among the collaborators have enabled the projects' success.

There, of course, could be a gap between academia and industry that would largely be a result of difference in objectives: academia seeking to create new knowledge and to disseminate it broadly, while business having a need to maximize profit and protect R&D results. For us, this cap has not been an issue, because when working together for decades in order to meet our missions, there is enough space in business to publish sufficient amount of results for theory and/or carefully selected and tested experiments. At the end of this presentation, I will present two examples of fruitful development projects for energy wood harvesting in sustainable energy production. Both examples of simulator education and multiple-tree processing are parts of our set mission of sustainable energy production.

SDWS2012.0588 Removing Barriers to Foster Productive Industrial Academic Partnerships

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Abstract

The history of industrial academic partnership is long and illustrious. There have been some truly innovative successes, as well as shameful outcomes, but the game has shifted over the last 100 years to that of bigger demands by academic institutions leading to the establishment of technology transfer offices. Does this facilitate collaboration or hinder it?

Is true collaboration a thing of the past? The high tech stakes are very high. Does big business prefer to keep their secrets in-house and pay the true innovators big bucks? Does an alternative supply chain need to be developed to link industry and academia in a different manner? What is the role of academics and researchers in this new supply chain? Can successful collaboration once again be achieved? Or will the institutions involved choke it slowly? Here I present the past, the present and look to the future in an open frank manner and present my own personal opinions. Questions are posed to raise debate and discussion.

SDWS2012.0589 Academia-Industrial Collaboration in Sustainable Development: Design and Implementation of Innovative Biological Emissions Control Technologies

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Abstract

Texas A&M University Kingsville and Met-Pro Environmental Solutions have collaborated on several well funded research partnerships resulting in successful projects demonstrating the efficacy of biological air emission treatment systems for control of volatile organic compounds and hazardous air pollutants over a 5 year period. Research funding alone achieved a level of almost $1M over the period resulting in several successful field installations by Met-Pro. The academic partners brought grant writing expertise, peer reviewed publication experience, hypothesis testing and data analysis to the project team, which enhanced the credibility of the technology for the sponsors; while the industrial partners brought project management, field experience, in-kind matching funds and support, and commercialization potential and markets for the technology to the group. Research funding was achieved by the Texas Higher Education Coordinating Board and the U.S. Department of Energy by the project team. Several successful field scale installations have been achieved for Forest Products Industry applications.

SDWS2012.0593 Industry Academia Relationship

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Abstract

This relationship has been always a little uneasy marriage. Both industry and academia need each other. However, their interests and priorities are by definition different in a number of directions. One of the tasks of this session is to discuss, indentify and possibly suggest solutions to the following questions: where those two partners have the identical interests, where are sources of possible conflicts of interest, and how can be this relation more beneficial for both sides. Industrial ventures need to maximise profit and provide as simple and low cost production of products demanded by the market – customers. A possible innovation is undertaken when it is no other option as it usually carries some extra cost and possible complications in well rehearsed and finally – after sometime difficulty tuning up and mastering – smoothly running production process. The industry needs rather specific and well targeted research leading to an optimal level of the innovation. Too high innovation level can be a problem, as the market may not be ready to accept at the particular time or some related/supporting products may not be ready yet. An industrial partner frequently has a limited number of academic institutions with whom they have got longer time experience in collaborating and/or proven confidentiality agreements. The academic institutions have got education as a primary activity, which means production of well trained and prepared graduates. However, beside this, a substantial part of universities' activities involve research, innovation, and collaborative applications. Those have been rather important especially for high quality postgraduate teaching, whilst the performing of different applications has always been regarded as the essential cornerstone for the professional development of engineering-oriented research groups. Research has been also an important source of income. However, academia is by the rules imposed by the regulating authorities and run by the recognition ambitions interested in early research publication. There is a problem with the confidentiality required by the industry. One of them is that when an industrial partner is financing the research, the benefit can be obtained by exclusive ownership of novel information, which has been conflicting with early publication. The academia is by definition open to wide networking and collaboration, which is one of major conditions for facilitating the research. The authors have long term experience from a number of collaborative research, demonstration, training and teaching projects with the industrial participation, which should provide the base for the discussion.

Energy planning I

Keynote presentation

SDWS2012.0356 Assessment of the Impact of Renewable Energy and Energy Efficiency Policies on the Macedonian Energy Sector Development

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Abstract

The main goal of this paper is to examine and quantify how the development of the energy system in Macedoniacould be influenced by policies and programs that promote energy efficiency and renewable energy, in terms of energy security and diversification, economic competitiveness and CO_2 mitigation. For this purpose the MARKAL-Macedonia national energy planning model was used.

These policies are explored by comparing a Reference (business-as-usual) development of energy system with three alternative policy scenarios: 1) Renewable Energy (RE) Scenario - introducing a renewable energy target by 2020; in line with that proposed by the Energy Community; 2) Energy Efficiency (EE) Scenario - promoting greater market penetration of improved energy efficient appliances by implementing appliance and building standards, limiting the use of inefficient devices and incentivizing improved devices; and 3) Combined RE and EE Scenario - a combination of supply-side and demand-side approaches which examine the resulting synergies of these policy goals. For each scenario the implications of least-cost investment options for new capacity builds, investment spending requirements, electricity prices, fuel expenditures, and carbon dioxide emissions were assessed.

The analyses have shown that even under the Reference scenario the reliance on electricity import will be reduced, as a result of increased gas import by 17%. The RE scenario reduces further the overall import by 3%, while the EE scenario by 8%. Total discounted costs of the energy system in the Reference scenario is estimated to nearly 15 €Billion, with investment of 3.2 €Billion for 2.34GW of new electricity generation capacity needed to meet the increased demand by 2030. The proposed RE target increases the cost of the energy system only by 0.2%, due to the availability of additional renewables, particularly hydro and biomass. The increased penetration of energy efficient

devices reduces total energy system costs by 2.6%, as a result of reduced fuel costs and decrease in the power plant capacity additions, amounting to an overall savings of 381 €Million. The baseline evolution of the energy system results in 50% increase of CO_2 emissions over the planning horizon. The analyzed RE and EE policies show strong synergies with a move to a lower carbon economy, resulting in cumulative CO_2 emissions reductions of 3.9% triggered by an overall drop in consumption and less use of fossil fuels.

SDWS2012.0073 Regional Energy Autarky: Potentials, Costs and Consequences for the Austrian Sauwald Region

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Abstract

Local actors at community level as well as politicians on regional and national level often thrive for energy autarky to increase security of supply and decrease the dependence on imported energy resources. We assess the potentials and trade-offs between benefits and costs of increasing levels of "energy autarky" for a small rural region of around 21.000 inhabitants in Upper Austria. We have collected and processed data on the spatial distribution of energy demand and biomass resource potentials from public authorities and companies in the region and have modeled demand and supply potentials using geographic information system tools. Heat demand is modeled spatially explicitly while photovoltaics, solar thermal, and various biomass conversion chains (including combined heat and power, small district heating plants and single dwelling boilers) are considered on the supply side. The impacts of increasing biomass demand for energy purposes on the agricultural sector are assessed with a detailed land-use optimization model that allows deriving supply curves for different types of feedstock in the region. An optimization model is subsequently fed with data on energy demand, supply potentials, and costs for different available energy conversion chains and applied to find the least cost solution for supplying the region with local energy resources, assuming different scenarios of "energy autarky". Model results indicate that fossil fuel use in the heating sector can be substituted at rather low costs by increasing forestry and agricultural biomass production. However,

autarky in both the electricity and the heating sector would significantly increase biomass production in forestry and agriculture and would require an almost full use of the technical potentials for the production of electricity by photovoltaics on roof tops. Attaining energy autarky implies high costs to consumers and the local production of food and feed would substantially decline. Consequently, regional energy production may lead to inefficient energy system setups under current future realistic scenario assumptions.

SDWS2012.0160 Optimal Wind Power Generation in Existing Serbian Power System.

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Abstract

Serbia has wind with good capacity factor, which respectable potential has been not used so far. There are a number of proposal projects with envisaged capacity of up to 2500 MW and proposed project documentation for 1300 MW in wind power plants. Within the existing feed in tariff scheme only 450 MW are eligible. This limitation is set in a conservative manner having in view technical problems due to intermittency of wind power generation. Within existing structure of power generation in Serbian power system, with the significant of hydro generation and available pumped storage hydro capacity and good exporting capacities there are lots of possibilities to provide ancillary services needed for reliable grid technical performance and for balancing the wind production. In this article the critical excess electricity production under different scenarios of wind power penetration into Serbian power system will be analyzed. Several options of technical constraints and the impact of the objective function will be qualified. Possible new technical control strategies for providing ancillary services for improved usage of available wind power production will be also discussed.

SDWS2012.0232 Managing of Hydro Energy Resources in a Power System with Integrated Res

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Abstract

This paper presents an approach for managing the hydro energy resources in a complex power system with integrated Renewable Energy Sources (RES). The proposed approach is applied on a specific system consisted of Thermal Power Plants (TPP), storage Hydro Power Plants (HPP), Pumped-Storage Hydro Power Plants (PSHPP), additional systems to deal with pumping water of PSHPP and Wind Power Plants (WPP).

At first the optimal power outputs of conventional power plants are determined. For this purpose an optimization method for solving the generation scheduling problem of such complex system is presented. The predicted power production of WPP is used as an input in this system. The optimization problem consists of minimizing the total production costs, respecting power balance equations for each time interval and all operation system constraints such as: power balance equations, constraints in the form of inequality for power output limits of thermal generating units and hydro generating units, power output limits of wind turbines, constraints for total available amount of water for storage hydro power plants and pumped-storage hydro power plants over the study period. The problem model does not take into account spinning reserve level, the system configuration and network losses.

The operation of HPPs is in such a way that overall available amount of water over the optimization period should be spent. For purposes of pumping water at pump storage hydro power plants, WPP will be engaged, if they are active in the intervals of the pump mode, and additional units engaged in energy for pumping. In the analyzed cases power unit's generation, thermal unit's fuel costs and stream flows of hydro units are calculated over the study period.

SDWS2012.0351 Employment as Indicator of EU Strategy 2020 Implementation – Measurement and Analysis

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Abstract

The aim of this paper is to find and represent dependence of changes in employment and sustainable development in the EU27. EU STRATEGY 2020 implies achievemnts of higher level of employment, and significant changes in energy sector. On the other side there is no unique employment policy in the Union, so importance of its harmonisation will be prominent. European union can be considered a leader in renewable energy applications, boosting high-tech industries, offering new economic opportunities and constituting a non-negligible source of industrial development and employment, so the monitoring report of the EU sustainable development strategy will be presented in the paper. Also, importance in energy sector restructuring, according to the Kyoto will be represented. Results show significant changes in employment rate in all EU countries, linked to changes in energy sector. Number of employees is on the same level or lower in comparison with the first year – 2005. All EU27 countries (except Germany, Austria and Belgium) recorded higher level of unemployment related to changes in energy sector. Manuscript showed that Kyoto protocol demands have signuificant impact on employments trends in energy sector. Strategic directions in area of energy sector restructuring is also presented.

SDWS2012.0553 The Importance of Jordan's Red Sea-Dead Sea Project for Integration of High Share of Intermittent Renewable Energy Sources

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Abstract

This paper presents the influence of the Red Sea-Dead Sea project and the desalination plant on the future energy systems of Jordan. The Red Sea-Dead Sea project and its alternative route have been used to increase penetration of intermittent Renewable Energy Sources, prevent decline of the Dead Sea and to provide fresh water for the increasing population of Jordan. The reference model of Jordan's energy system for the year 2009 has been reconstructed by using EnergyPLAN tool. The results of the reference model have been compared with current data in order to determine the accuracy of the model. Based on the reference model and future needs for energy and water in Jordan, four future scenarios, covering period until 2050 and different type of technology, have been developed and analyzed in EnergyPLAN tool. The results of analysis shows that Red Sea-Dead Sea desalination system can both provide the Dead Sea with the necessary salt water to prevent its decline and fresh water for the population of Jordan. Furthermore, a flexible nature of proposed desalinization system can help to achieve a higher penetration of renewables in Jordan's energy system.

Life cycle assessment

Keynote presentation

SDWS2012.0159 Life Cycle Analysis of the Integral Water Cycle in a City: a Guide for a Sustainable Planning

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Abstract

Life cycle analysis (LCA) is a well-known methodology to establish the environmental penalties associated to any product or process. Main advantage of LCA is its complete scope: it considers the whole life cycle of the environmental charges associated to a product or process. Major drawback consists in the huge amount of information required to carry out the inventory list of incoming materials and/or processes, especially if the analyzed system is complex or the required information is not available. Within water sector, LCA is becoming more and more significant to evaluate the additional environmental loads, not directly related to the energy consumption. This analysis is crucial when several alternatives for the same purpose could be selected. For instance, if diverse collecting water supply alternatives are feasible for a city, it is very interesting to allocate their different environmental load to discern which the best one is. On the other hand, when the complete analysis of all stages in the integral water cycle of a city is compiled, the interest is then focused in the comparison between the different water stages, and especially in the assessment of the environmental load associated to civil works performed in water supply and drainage networks, as well as in the environmental penalty associated to operation of water supply and wastewater plants. The present paper shows the results of the complete LCA analysis of the city of Zaragoza (700000 inhabitants). Zaragoza is the biggest city of the Ebro Valley in Spain, and has three diverse collecting surface water systems for its raw water collection, as well as two wastewater plants (with different sludge treatment). SimaPro software (version 7.2.2) was used to perform the LCA analysis, and three different evaluation methods were developed: ReciPe, IPCC 2001 GWP y Eco-indicator 99. For all methods, the results show that environmental load associated to civil works is really important in the water supply and drainage systems of Zaragoza, as well as in a collecting alternative (water derived from the Pyrenees). With respect to the energy consumed in the water cycle, of course energy consumed in dwelling uses (to produce HSW) exceeds by far the environmental impact provoked by energy and chemical reagents of the other stages (water treatment and wastewater plants, pumping stations). Finally, the analysis of existing wastewater plants, biogas produced with dry sludge treatment is lightly better in

terms of lower environmental impact than its proper combustion in a fluidized bed. Thanks to the support of Zaragoza city council technicians, it was possible to perform, for the first time, a complete LCA analysis of the water cycle of a medium-size city, by using real inventory data. Keeping some caution, results could be extrapolated to cities with similar characteristics than Zaragoza, as a guide to measure the sustainability of new or already existing water supply systems.

SDWS2012.0019 Comparison of Energy Consumption in Life Cycle of Two Types of Taps

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Abstract

The choice between different materials, products and systems employed in the construction sector may consider economic, social, cultural and environmental criteria. In the case of plumbing fixtures, economic evaluation and water consumption comparisons are the most frequently used criteria. This main objective of the paper is to propose a method for quantifying the energy consumption of plumbing fixtures based on the concept of Life Cycle Assessment. The method quantifies the energy consumption in the production, use and disposal phases of the plumbing fixtures under analysis. This allows for the comparison between the performances of different plumbing fixtures in terms of energy consumption. It also allows for the identification of the phases that present the higher contributions to the total energy consumption in the life cycle of the fixtures. The method considers the energy requirements to allow water provision for the plumbing fixture in the use phase. This includes the energy needs for potable water treatment and distribution, for the pumping system in the building and for subsequent treatment of sewage. Thus, the higher the water consumption of the fixture, the greater the energy consumption associated. The proposed method was applied in the Water Conservation Programme of a university campus inSouthern Brazilto quantify energy consumption in the life cycle of two types of taps. The total energy consumption in the life cycle of ordinary and water-saving taps used in the study was respectively, 158.1 MJ and 136.6 MJ. The energy consumption was found to be higher in the use phase, i.e., 64.9% for conventional and 55.3% for self-closing taps. The proposed method has proven to be adequate for energy consumption quantification in life cycle and subsequent choice between different plumbing fixtures that perform the same function.

SDWS2012.0109 LCA of the Environmental Performance of Iron Based Nanoscale Catalysts for the Conversion of CO_2 into Fuels and Chemical Feedstocks

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Abstract

This study uses the life cycle assessment (LCA) tool to measure the environmental performance of a range of iron based nanoscale catalysts for the conversion of CO_2 into useful chemical compounds including alkanes and alkenes.

The utilisation of waste or airborne CO_2 is seen as a key step in reducing the amount of greenhouse gases prevalent in the atmosphere. The chemicals formed in this reported catalytic process have applications as propellants, solvents, polymers, and fuels. There is, therefore, the potential of additional benefits associated with offsetting the impacts of these chemicals traditionally formed through the use of fossil fuels and environmentally damaging petrochemical processes.

This paper also proposes a method of measuring catalyst selection as a function of embedded environmental impact rather than purely energy use or economic cost of production. This work is seen as a step towards realising the goals set out by the principles of green chemistry, such as: the selection of more environmentally sound chemical products, the preferential use of renewable raw materials and feedstocks over depleting sources where technically and economically possible, and catalytic reagents being superior to stoichiometric reagents.

The synthesis and testing of the catalyst materials has been conducted at laboratory scale. Scale up of these processes has been made in order for LCA results of the chemicals formed (methane, ethane, ethene, propane, propene, butane, butane, pentane, and hexane) to be analysed and the major impacts identified. These results have then been directly compared for the chemicals formed via other established petrochemical routes, as reported in, for example, the Ecoinvent inventory dataset.

SDWS2012.0314 Environmental Assessment of CCHP Systems Based on Biomass Combustion in Comparison to Conventional Generation

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Abstract

One alternative to increment and improve the use of biomass resources and distributed generation are the combined cooling, heating and power (CCHP) small-scale plants. In this work, biomass CCHP systems based on biomass combustion are evaluated to provide a basis for studies on environmental feasibility through Life Cycle Assessment (LCA) methodology. The first step of this work is to review the technologies involved in CCHP systems based on biomass combustion, i.e., organic Rankine cycles (ORC), Stirling engines (SE) and thermally activated technologies (TAT) for refrigeration (absorption and adsorption chillers). Through the reviewed characteristics of the currently available technologies in the market, a thermodynamic model of all subsystems general integration is developed in order to design a CCHP plant in terms of biomass consumption and plant nominal power based on the variation of the heating and cooling demands. The results of the thermodynamic model are the base to develop LCA for every possible configuration in which the reviewed technologies might be integrated. The environmental impact is obtained for every configuration, in terms of the selected method of evaluation, depending on the variable heating and cooling loads. Furthermore, these results are compared with the impact of a reference stand-alone system with the same amounts of cooling, heating and power than the proposed CCHP system, in order to quantify the difference between the two systems for every considered impact category. This comparison reflects that the best plant is not always obvious and the demands and the plant configuration might limit the application of CCHP based on biomass combustion. As a result, some guidelines are proposed to develop small-scale CCHP plants based on biomass combustion in an environmentally friendly way, which will contribute to efficient plant design in combination with other guidelines based, for example, on primary energy savings and global efficiency, amongst others.

SDWS2012.0311 Environmental Life Cycle Assessment of Transportation Fuel from Lignocellulosic Biomass

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Abstract

Concerns about sustainability and security of fossil fuel use, along with advances in biomass conversion technology, simulate the interested in ethanol production from lignocelluloses. Studies carrying out life cycle assessment of lignocellulosic bioethanol production have been conducted in the recent years. Most of the impact assessment studies presented in the literature have focused on energy and carbon accounting. However, a wider range of environmental issues should be considered to provide an overall view of the sustainability of lignocellulosic ethanol conversion

In this paper, a comprehensive life cycle assessment was carried out to assess the environmental burdens of the production of ethanol and its use as ethanol blend fuels. Two types of UK typical biomass – wheat straw and barley were used as feedstocks. Two ethanol-based fuel E15 (a mixture of 15% ethanol and 85% petrol by volume) and E85 (85% ethanol and 15% petrol by volume) were assessed and the results were compared to those of conventional petrol in one kilometre driven by an equivalent car. The assessment takes into account biomass cultivation, processing, transport, conversion and final use of products, along with the use of chemicals, enzymes and nutrients as well as manufacture infrastructure.

The environmental performance was studied using ReCiPe methodology and includes global warming, photochemical oxidant formation, acidification, ecotoxicity, eutrophication, water depletion and fossil depletion. The results show that, compared to petrol, life cycle greenhouse gases emissions are lower for ethanol blends, with a 73% reduction for an E85-fueled car and 13% reduction with E15. A modest savings of 40% in fossil depletion was also found when using E85 and 15% when using E15 in comparison with the conventional petrol. Similar results are also observed for ozone depletion. The findings also highlight a number of environmental issues such as acidification, eutrophication, ecotoxicity and water depletion for which areas ethanol blend use does not offer any advantages compared with petrol. The further investigation of the ethanol production at well to gate level shows how much each unit process of conversion contributes to the environmental burdens thus suggest where efforts should be placed in order to minimise the environmental impact.

SDWS2012.0444 Bitumen Road Paving and Tank Filling Processes – a Still Important and not Solved Environmental Issue.

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Abstract

An environmental as well as occupational hygiene impact of bitumen fumes is currently widely discussed. A bitumen, as a product of vacuum residuum processing, besides of main –high-molecular – compounds, contain a small amounts of volatile organic compounds (VOC). It results from a thermal cracking process, which takes place at the heating elements of batches in vacuum distillation column as well as during the bitumen oxidation. A part of VOC remains dissolved in the bitumen.

During a non-hermetic or open tank-filling to the autocisterns an emission of bitumen fumes to the atmosphere takes place. An analysis of the bitumen fumes composition reveals that a bitumen microdroplets and VOC's are present. Similar phenomenas, but in a small magnitude take place during road paving operations. A results from different parts of the world show big differences of data produced by methods used in environmental protection agencies. Still thera are no standard methods for simulation of this phenomena in laboratory conditions.

The paper presents a state of the art and current knowledge aout the composition and toxicity of bitumen fumes as well as own methodologies and results of research on determination of VOC's and bitumen fumes emitted during tank filling and road paving operations.

The research has been made in real and simulated conditions. The emission of VOC has been studied with the use of gas chromatography (GC) with universal and selective detection. A gas chromatography mass spectrometry (GC-MS) has been used for identification of particular compounds. A sorption tubes has been used for sampling of the VOCs. A composition and concentration of bitumen microdroplets has been studied with the use of size exclusion chromatography (GPC/SEC) and normal phase thin layer chromatography coupled with flame ionization detector (TLC-FID). A granulometric analysis as well as toxicity assessment of bitumen fumes has been also described.

Energy system analysis I

Keynote presentation

SDWS2012.0106 Energy and Environmental Performance of Industrial Combined Heat and Power (CHP) in the Context of a Low Carbon UK

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Abstract

The UK has targets to reduce carbon emissions by 80% by 2050 compared to a 1990 baseline. The Transition Pathways research consortium has generated a set of three low carbon UK electrical futures, together with the corresponding technology mixes. The pathways are based on alternative mechanisms for the governance of the Electricity Supply Industry (ESI), and account for the roles of 'actors' large and small. All require a significant amount of technological change, including a significant increase in the contribution of combined heat and power (CHP) schemes. CHP technologies use the primary fuel more efficiently by capturing the heat produced in electricity generation, or, to put it conversely, simultaneously generate electricity in the production of useful heat. The EU Cogeneration Directive sets down the standard that 'Good Quality' CHP must delivery 10% savings on primary fuel used compared to separate conventional generation. In 2010 UK CHP schemes contributed approximately 7% of the national electricity supply capacity, and 89% of the CHP electrical capacity was generated by schemes in the industrial sector. A number of ongoing studies, including the Transition Pathways work, believe that there is still a large opportunity for CHP roll out in the UK. This study investigates the appropriateness of industrial CHP as a low carbon electricity generation technology for the UK and outlines: how the energy and carbon savings in operation compare with the energy expanded and carbon emitted in the technology conversion process; the wider environmental consequences of converting to a CHP scheme; and the total potential contribution to carbon reduction targets that can be made by industrial CHP in the UK. This was carried out via an environmental life cycle assessment (LCA) case study of an existing CHP plant in the UK. Data was collected during site visits and via discussion with plant engineers. Remaining data gaps are filled via literature review of studies completed on similar technology examples. The results of the assessment carried out on the case study plant give an indication of the energy and carbon savings that could be made by harnessing the predicted UK wide industrial heat available for CHP application. These findings appraise and inform the Transition Pathway Scenario work.

SDWS2012.0204 Modeling, Simulation and Analysis of Full Power Converter Wind Turbine with Permanent Synchronous Generator

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Abstract

This paper focuses on PSS/E modeling and simulation of wind farms of full converter wind turbine with permanent magnet synchronous generator type and their impact on issues of Kosovo power system operation. The proper modeling of wind farm projects in systems studies is becoming increasingly important to system operators. In the past decade, wind power has evolved into a significant renewable energy source which continues to grow rapidly. The increased size of wind power projects and the development of large wind parks bring about a number of opportunities and challenges. Wind grid code currently require wind turbine to have high immunity against grid faults. In addition, wind turbines that are able to provide more reactive power support are increasingly preferred. This feature can be found in a full converter wind turbines with permanent synchronous generator.

SDWS2012.0054 Multi-Criteria Analysis of Electricity Supply Using Analytical Hierarchy Process – Case Study Slovenia

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Abstract

Modern energy planning, in view of its complexity, must satisfy a number of economic, social and environmental parameters which demands a comprehensive planning approach. Conflicting objectives often require the consideration of several stakeholders and for that

purpose use of multi-criteria methods is necessary. During the preparation of the new Slovenian National Energy Programme proposal analysis of five different national electricity supply scenarios has been made. Scenarios varied due to different power plant portfolios in accordance with projected national energy demand up to 2030. The decision alternatives were calculated using reference energy and environment system model for Slovenia which enabled the comparison and assessment of various demand and supply strategies and scenarios, economic evaluation and calculations of long term energy and emission balances. Analysis of scenarios has been done with analytic hierarchy process multi-criteria technique where the preferences of the decision maker are accommodated by pairwise comparisons between the decision elements. During the analysis, special attention was given to the selection of the appropriate criterions, decision importance ratios and to the detection of inconsistent judgments used in the analytic hierarchy process. Within the paper the main technical, economical and environmental characteristics of the Slovenian energy system are described having in mind different decision alternatives. Also, principles of the analytic hierarchy process and its properties with regard to an illustrative national energy policy planning example are presented. At the end barriers, strengths and weaknesses of the analytic hierarchy process and its role in the national policy planning process are discussed.

SDWS2012.0181 Modelling Long-Term Dynamical Evolution of Southeast European Power Transmission System

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Abstract

Southeast European power transmission system is modelled as a whole by analyzing the system as an evolving grid that is continually upgrading to satisfy an increasing load demand and reliability requirements. We adopt a model (known as OPA model) which satisfies two requirements. First, the model is based on probabilistic line outages and overloads and it models the network using DC load flow and linear programming dispatch of generation. Second, the model includes systematic upgrading the production and transmission capacities of the electric-power system. The applied model answers the question to what extend the network and the production facilities should be upgraded to meet the growing demand in electricity. The OPA model depends on few key parameters.

In this paper, the appropriate parameter ranges are found that bring the Southeast European power transmission system in a stable dynamical evolution. Also, large daily fluctuations in the consumption of the nodes, which is a real problem in the electric power systems, are included in the system. One of the parameters that the system evolution depends on is the excess of electricity generation in response to power demand, which is varied in the range of 20% to 30%. Comparing with the actual excess, it can be concluded that merging the electric power systems of the separate countries in the region into a common trade will produce a great economic benefit in investment of new generation capacities. Moreover, the results show the most vulnerable transmission lines of the Southeast European power transmission system that are needed for upgrading.

SDWS2012.0036 Computational Investigation on the Multiphase Flow Capabilities of Using Water and Ethanol as Heat Pipe Working Fluid

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Abstract

Advancements of computational capabilities have increased the development of heat pipe applications, depicting complex multiphase flow regimes and highlighting the broad scope of the respective technology for utilization in passive and active applications. A benchmark channel sectional heat pipe heat exchanger was modeled and multiphase flow behavior of two-phase heat pipe working fluids including water and ethanol was investigated using Computational Fluid Dynamics (CFD). Thermal properties of the two fluids were employed to systematically obtain the rate of evaporation and applied heat flux at an operating temperature range between 293 and 318K. Temperature and velocity profiles across the control volume of the 13 cylindrical heat pipes were obtained from the analytical and numerical simulations.

Inlet air temperatures from the hot and cold channels were kept constant at 323K and 283K. At heat pipe saturation properties of 293K, the temperature at the outlet face of the hot duct containing ethanol as the working fluid for heat pipes was obtained at 311K, displaying an increase of 3.6K in comparison to the temperature at the outlet of the hot duct containing water which displayed 307K respectively. Heat transfer rates to the evaporator and condenser sections were computed to be 113 and 106W for water as the working fluid. The present study established the performance results of the heat pipe matrix within the computational channel domain using water and ethanol as the working

fluids, by investigating the transient volume fraction formations and planar temperature differentials and analytically modeling the sectional rate of heat transfer respectively.

SDWS2012.0037 Numerical Investigation of the Integration of Heat Transfer Devices into Wind Tower

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Abstract

Increasing focus on reducing energy consumption has raised public awareness of renewable energy resources, particularly the integration of natural ventilation devices in buildings such as wind tower systems. Wind towers have traditionally been used in Middle Eastern architecture for many centuries to provide natural ventilation and thermal comfort. The purpose of this study is to integrate heat transfer devices in a wind tower to meet the internal comfort criteria in extreme external condtions. Heat transfer devices were installed inside the passive terminal of the wind tower unit, highlighting the potential to achieve minimal restriction in the external air flow stream while ensuring maximum contact time, thus optimzing the cooling duty of the device. A geometrical representation of a full scale wind tower configuration, micro-climate and macro-climate was modeled. Computational Fluid Dynamics (CFD) was used to develop a numerical model of a new wind tower system and simulate the air flow pattern and pressure coefficients around and through the wind tower to the test room. Results have indicated that the average internal airflow rate was reduced following the integration of the vertical and heat pipe configuration, reductions of 4.11% and 8.21% was obtained from the achieved numerical models. The work highlighted the effect of the heat transfer devices on the thermal performance of the passive ventilation device. For the benchmark geometry, air temperature reductions of 1.2 K and 2.7 K were obtained inside the microclimate for external wind speeds of 1 and 4 m/s. Indoor temperature is reduced by 0.32% and 0.65% when the heat transfer devices are positioned in the vertical and horizontal orientations.

Water policy and the energy-water interaction

Keynote presentation

SDWS2012.0177 Managing Water Resource Futures and Their Connection to Land and Energy Resources

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Abstract

Effective management is key to ensuring the current and future sustainability of land, water and energy resources. Identifying the complexities of such management is not an easy task, especially since past studies have focussed on studying these resources in isolation from one another. However, with rapid population growth and an increase in the awareness of a potential change in climatic conditions that may affect the demand and supply of food, water and energy, there has been a growing need to integrate the planning decisions relating to these three resources. This paper describes a novel dynamic tool which shows the visualisation of linked resource futures by drawing a set of interconnected Sankey diagrams for energy, water and land. These track the changes from basic resource (e.g. coal, surface water, groundwater and cropland) through transformations (e.g. fuel refining and desalination) to final services (e.g. sustenance, hygiene and transportation).

The focus here is on the water analysis aspects of the tool, which uses California as a detailed case study. The future movement of water in California is traced from its source to its services by mapping the different transformations of water from when it becomes available, through its use, to further treatment, to final sinks (including recycling and reuse of that resource). The connections that water has with energy and land resources for the state of California are highlighted. This includes the amount of energy used to pump and treat water, and the amount of water used for energy production and the land resources which create a water demand to produce crops for food. By mapping water in this way, policy-makers and resource managers can more easily understand the competing uses of water (environment, agriculture and urban use) through the identification of the services it delivers (e.g. sanitation, agriculture, landscaping), the potential opportunities for improving the management of the resource (e.g. building new desalination plants, reducing the demand for services), and the connections with other resources which are often overlooked in a traditional sector-based management strategy.

SDWS2012.0097 Macedonian Water Management Policy and Climate Change

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Abstract

The existing national legislation on waters considers protective measures applicable in case of harmful effects of waters. Although, the subject was included in the legislative text as part of the EU overall objectives for sound European water management, the adaptation was an issue which, at the time of the adoption of the law, was not EC regulated in detail. Consequently, it does not explicitly mention risks posed by climate change to the achievement of environmental objectives. Subsequently, the progressive development of the i EU law relevant to the subject matter, imposed framework for reduction of the vulnerability to the impact of climate change.

This paper aims to examine whether and to what extend the Macedonian water legislation incorporates consideration of climate variability and change into the implementation of the water policy. It gives and overview on the ability of the national water management policy and to allow and support adaptation to climate change, in particular to the national boundary river basin management (RBM) planning cycles, through the prism of the positive Macedonian legislation. It considers which steps in RBM are most important in adaptation to climate change. Its final objective is to define how to build adaptive capacity for management of waters under climate change. Considering the complexity of the interactions of the national water management and climate change policy, this paper examines some trans- boundary aspects of the issue resulting in need to develop joint and coordinated adaptation strategies for international RBM.

The standing is that the current legislation is deficient in norms and principles for adaptation to climate change. Also, it stands that the Macedonian water management policy and planning should incorporate climate change ratio within the management, thus becoming adaptive water management. At the end, it is concluded that the inclusion, aiming to delivery of adaptation to the climate change, should be done in each particular stage of the development of the RBM planning, some of which considered as most important in adaptation to climate change. It also, gives suggestions how in terms of law-making activities, the existence of the legal gaps may be removed.

SDWS2012.0323 How to Increase Drinking Water Networks Efficiency and Optimize Green Electricity Production, by Means of Interconnection

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Abstract

Motivation: Municipalities face to worldwide disparities in terms of water resource and consumption. Usually, plain regions are places where most of the human activities take place, namely residential, commercial and industrial activities and in which population, energy and water consumption are still growing. Satisfying the drinking water demand leads plain regions to implement technical and cost-intensive measures mainly based on pumping and treatment systems to extract groundwater if existing. In contrast, mountain regions are often characterized by a high concentration of natural spring water and low water consumption because of a proportionally low population density in non-tourist regions. As a consequence an important amount of immaculate spring water is tapped but not consumed in these mountain regions and then spilled in surrounding rivers. Drinking water potential as well as energetic value is then lost.

Objectives: With the concept of interconnection among municipal drinking water networks this project aims to present an innovative methodology to identify potential interconnections between municipal separated networks, at a regional level. Major objective of this project is to develop a unique map tool designed for regional decision-maker helping them to identify and implement potential interconnection between municipal separated networks.

Results: The first part of this project concentrates on the creation of a regional map which is highlighting the following aspects:

- potable water demand or excess of each municipality today and in the future,
- costs and energy consumption involved by pumping and treatment systems,
- potential hydropower generation enabled by a future interconnection,
- possible interconnections based on the topographic relief, the positioning of the water springs and the existing drinking water networks.

This methodology based on the experiences collected in a regional case study (23 municipalities) can be replicated in any others regions.

Conclusion: The success of sustainable water management depends on the ability of local decisions-makers to integrate a sum of complex and dissociated elements. The presented tool brings these elements together giving decisions-makers an overview focused on value adding in terms of economic and energetic aspects.

SDWS2012.0061 Integrated Water-Energy-GHG Management for a Sustainable Future

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Abstract

Energy use and its associated greenhouse gas (GHG) emissions form an integral part in every step of the urban water provision; however the links between water and energy are poorly understood and not well recognised. It's been estimated that 7% of global energy use is utilized for water provision. For example, Melbourne Water is among the top 15 electricity users in Victoria and the top 150 in Australia and used 1.64 PJ of energy in 2009/10 costing $20.2 million on energy. Operational GHG emissions were 351 kt $CO_{2\text{-}e}$. Given the importance of water and energy for society, the need for improved decision-making in water provision and associated energy use & GHG emissions is well recognized. A basic conceptual framework has been developed to quantify life cycle energy use and greenhouse gas emission of urban water systems using LCA and supply chain approach. Issues relevant to the developed framework are discussed with respect to household water demand. It was found that identification of the water supply sources, infrastructure processes used for transport and treatment of water, the wastewater collection and treatment, embodied greenhouse gas emissions of materials used and energy use associated with each component of water systems, are essential for the estimation of annual life cycle greenhouse gas emissions.

SDWS2012.0170 A Reliable, Flexible and Sustainable Water & Energy Integration: an Small Batch Electrodyalisis (ED) Plant Fed by a Photovoltaic (PV) Unit

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Abstract

The shortage of drinking water is a serious problem in numerous low-density dry population areas. In these areas, the use of water from underground reservoirs (most of them overexploited or suffering from saline contamination if they are close to sea) is essential to maintain its weak sustainability.

The use of electrodialysis (ED) allows obtaining a relatively low-cost and variable drinking water production from brackish water. One of the advantages between ED and other desalination techniques is that the driving force comes from applying a direct current potential gradient between electrodes, which is exactly the type of energy that PV systems supply.

This natural link between water production and renewable energy source is thoroughly analyzed in this paper. In particular, a small electrodialysis pilot batch plant was coupled to a PV arrangement specifically designed to be connected to the ED unit (it consist of 4 similar PV panels with 1, 2, 3, 6 or 12 connected mono crystalline Si cells, taking into account that 14V is the maximum voltage supply to the ED unit). A set of experimental tests were conducted with diverse configurations of the PV arrangement (, irradiation conditions, and different initial NaCl concentration raw in water (from 600 to 5.000 mS/cm), in order to test the feasibility of the integrated schemes, as well as to find out the optimum PV seasonal configuration to convert saline water into a drinkable resource.

In addition to experimental tests, a mathematical simulation model was formulated to allow prediction of the system performance. Simulation takes into account the principles of mass transport, current density distribution, cell voltage, mass balance and the energy consumption for the ED unit, and typical modeling for the PV equivalent circuit. Data given by the mathematical simulation model were successfully contrasted with experimental results in order to predict the reliability of the model (necessary time for successful desalination, electrical consumption, etc.) and to find out some theoretical parameters not given by the ED supplier. In this way, the scale-up of this small pilot plant to bigger applications of coupled ED-PV systems in dessert areas could be carried out.

Agriculture and Food

Keynote presentation

SDWS2012.0540 Lifelong Learning for Farmers: Enhancing Competitiveness, Knowledge Transfer and Innovation in Support of Sustainable Production Systems

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Abstract

Agriculture faces both, an increasing demand for food and a reduced supply of soil, water, energy and other scarce factors. Climate change and the related policies impact on the industry. It is obvious that the framework for agricultural production is changing.

Under these conditions, farmers adapt production and management systems aiming to maintain or even enhance the competitiveness of their businesses. This development of more efficient farming systems relies on the implementation of technology and management innovations into work routines. Knowledge transfer from researchers to farmers and among farmers can ensure a widespread application of innovative ideas and techniques which is crucial for a sustainable growth in food (and non-food) production.

This paper focuses on the effectiveness of lifelong learning approaches for farmers. It focuses on typical farming and production systems in the Federal State of Brandenburg in north-eastern Germany. The paper is based on first results from the research project "Lifelong Learning in Brandenburgian farms", funded by the European Structural Fund (ESF) and the Federal State and implemented by a team of agricultural economists from the University of Applied Science in Eberswalde. The paper explores lifelong learning in agriculture. It reflects on the approach used and discusses lessons learned so far.

The project is based on the idea of strong partnerships,

- firstly in the form of farmer networks: beef cattle, sheep, dairy and arable farmers participate regularly in seminars focussing on farm economics, sustainable production systems and the related policy schemes;

- secondly, in respect of the cooperation between institutions like administrative bodies and for example organic farming associations;

- thirdly, the partnership between research, namely the Institute of Farm Economics, the university team, institutions and farmer networks.

The conference paper will show that life long learning approaches are promising tools to foster knowledge transfer enhancing sustainable farming systems. The project helps to understand limiting and enabling factors and to develop more effective ways forward.

SDWS2012.0165 Distillery Stillage as a New Substrate for Lactic Acid and Biomass Production

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Abstract

Distillery stillage is a waste product of bioethanol industry with a harmful ecological impact. The costs of its treatment prior to disposal can seriously affect the financial aspect of bioethanol production. However, the stillage utilization for lactic acid production could improve the profitability of the process. The stillage could be used as a healthy animal feed enriched with probiotic lactic acid bacteria remained after the lactic acid fermentation. Nowadays, a sustainable production of lactic acid on cheap and renewable substrates is a challenge encouraged by growing demands of pharmaceutical, food and plastic industries for the lactic acid. Batch and fed-batch fermentation strategies for lactic acid production on distillery stillage with minimal supplementation were preformed by Lactobacillus rhamnosus ATCC 7469. The initial sugar concentration in the stillage (obtained from bioethanol factory Reahem, Srbobran) was adjusted with a sterile glucose solution and different fermentation strategies were studied. Fermentations were initiated with addition of 5% (v/v) of L. rhamnosus ATCC 7469 culture and performed at 41 oC, under microaerophilic conditions, with shaking (90 rpm). During the fermentation, lactic acid concentration (enzymatic method), reducing sugar concentration (spectrophotometric method according to Miller) and a viable cell number (pour plate technique) were determined. In batch fermentation, the most efficient sugar conversion was attained with initial sugar concentration of 55 g L-1. A high lactic acid productivity of 1.80 g L-1 h-1 and a very high number of viable cells (108 CFU/ml) were achieved in fed-batch fermentation. The high productivity of fed-batch fermentation on the stillage without any nitrogen or mineral supplementations qualified it as a promising substrate for parallel production of lactic acid and animal feed enriched with biomass.

SDWS2012.0499 Hplc Determination of Vitamin C from Indigenous Parsley Extracts Obtained by Different Extraction Techniques

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Abstract

Parsley (Petroselinum crispum), probably the most popular flavored herb of Romanian cuisine, along with lovage and dill, hides a treasure of vitamins and minerals. Parsley is four times more rich in vitamin C than orange, and its iron content is much higher than in spinach. The extracts were obtained by various modern and classical methods, like: sonication, extraction in microwave field, centrifugation. The experiments were performed at room temperature (centrifugation and sonication) and 30°C (extraction in microwave field), using 8 % (w/v) aqueous solution of the following acids: acetic acid, oxalic acid, m-phosphoric acid and trichloroacetic acid. The obtaining of the extracts was performed in a Transsonic T 310 bath with 35kHz frequency and 95W installed power, respectively in a continuous microwave field using a Monowave 300, Anton Paar equipment. The obtained extracts were analyzed by high performance liquid chromatography using a C18 Alltima column (3µ, 100 x 3 mm). The elution was performed in gradient, with 15 mM phosphate buffer at pH 2.7 (A) and methanol (B) as follows: from 10% B to 20% B in 5 min and from 20% to 10% in 10 min. The column oven temperature was set to 30°C and the flow debit was 0.4 ml min. The chromatograms were compared and it was observed that the highest quantity of vitamin C was obtained by sonication with 8% m-phosphoric acid.

Acknowledgements

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SDWS2012.0385 Fuzzy Logic Based Control for Protected Cultivation

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Abstract

This paper aims to present new, alternative ways of designing control systems for protected food cultivation. Use of Hydroponics allows drastically reduced amount of irrigation water. At the same time, it allows increased density of plants per unit area, reduces impact from climate changes, as well as application of bio control as an effective alternative to traditional methods of plant protection.

The role of the greenhouse in protected cultivation is to provide optimal microclimate conditions for plant growth. From the system theory aspect this is a very complex system including number of subsystems with emphasized interactions. All growing phases can be controlled through Control of Air Temperature, Relative Humidity, CO2, Lighting and Irrigation (Van Straten et al, 2010). Good overview can be found in (Soto- Zarazua et al. 2011).

Based on obtained data from sensors, and adequate algorithms, different actuators (motors, heat pumps, coolers, HID lights, etc.) can be activated in order to keep the measured variables in optimal range.

The most used control strategies are Timing Control, ON/OFF Control and PID Control systems. They can partially cope with the systems complexity, nonlinearity and emphasized subsystem interactions, so alternative strategies based on Neural Networks, Genetic Algorithms and Fuzzy logic are under consideration with different success.

Fuzzy logic (Zadeh, 1993) is mathematical theory dealing with uncertainty. This approach is intuitive, input and output variables are linguistically described, and design of control algorithm is based on if-then-else-if-not rules. Fuzzy Logic Controllers are widely used in different engineering areas (Phillips&Davis, 2008) including biochemistry, AI and Expert systems (Iliev et al. 1996, 1999)

In the presented system input (sensor) variables are: Indoor Air temperature (IT), Relative Humidity (RH), and the Level of Carbon Dioxide (CO2) inside the greenhouse. Output (Actuator) variables are: Heating system, Windows position, Fogger system, and CO2 dosing system. All of them are in crisp presentation between 0 and 1 (0-100 % active). Designed Fuzzy Controller use Mamdani's fuzzy inference method. On the following

pictures are presented behaviour of Fogger subsystem based on Temperature and RH, and behaviour of CO2 Dosing subsystem based on temperature and concentration of CO2.

According to the obtained results Fuzzy logic controller can cope with full complexity of this kind of systems. The following research will be in comparative simulation between Fuzzy logic controller and classical controller applied on real field in Kocani, Republic of Macedonia. The simulation will help in adjusting the input/output membership functions, and to make comparison from the aspect of energy efficiency, quantity of irrigation water and yield.

SDWS2012.0052 Global Biomass Needs for Food, Feed and Fuel in the Near Future

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Abstract

In recent years prices on global food markets showed large fluctuations. The use of biomass as energy source (biofuel) in the developed world is frequently mentioned as one of the reasons for this instability. The present use of biofuels is very small (less than 1% of total energy use), but is expected to increase fast in the coming decade, since in most Climate Policy Plans aim at 10% of the all transport fuels should be from biomass by the year 2020. However, since the present very small biofuel use is associated with rising food prices on global food markets and food security problems in Africa and Asia, it is essential to evaluate the possible impacts of increased use of biofuels on global markets to prevent global food security problems in near future. In here we only focus on the demand side and determine present and future needs for food, feed and fuel and compare their order of magnitude. We assume that when need for biomass for fuel is small in comparison with the need for food and feed is not likely that the need for biofuel will have large effects on global food prices. A simple model is developed to estimate present and near future global needs for food, livestock feed and energy. We distinguish between developing countries, transition countries and the developed countries. The first group of countries needs extra food for their growing population, the second one needs extra feed, since the increased incomes among their population lead to increased demands for animal products. The developed countries require biomass to reduce the CO2 emissions of their energy use. On global scale the extra needs for biomass as a fuel (1100 MT) turn out to be larger than the extra needs for food and feed (800 MT each). This implies that global need for biomass as a fuel is large in comparison with the needs for food and that use of biomass as fuel is likely to affect food security. Next to this at present the developed

countries are food exporters, their produce is essential for several food insecure countries in Africa and Asia. The increased need for biomass for energy in developed countries is likely to affect these exports and therefore affect food security in parts of the world.

SDWS2012.0343 The Environmental Impacts of Utilising Wheat, Wheat Straw Or Energy Grasses for Biofuel Production.

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Abstract

Concerns over the potential negative impacts of '1st generation' biofuels on food prices, land use and biodiversity have led to increased interest of utilising non-food crops as biofuel resources. Resources such as straw, woody residues from forestry or the waste stream, and purposely grown energy crops can all be used as a feedstock for lignocellulose-based bioethanol. Lignocellulosic bioethanol (and ethanol produced via gasification) is considered to be a '2nd generation' biofuel as it represents a new wave of biofuels, being produced from non-food crops using more recently developed, and still developing, technology. It is suggested that these future biofuels could reduce negative indirect impacts by being more broadly sourced from a range of abundant, readily available and low-cost resources. This paper discusses two significant sources of lignocellulosic biomass: cereal residues and purposely grown energy grasses, in this case, Miscanthus. Cereal residues are already grown on millions of hectares over Europe, however, on a per hectare basis they are relatively low yielding, and their availability may be limited by competition with alternative markets, or their importance for maintaining soil structure and function. There is huge potential for expansion of Energy grasses in Europe, and yields up to 30-40t/ha can be achieved in some regions, however there are concerns that using land for such crops can lead to increased demand on land, leading to indirect land use change.

This research involves examining the relative sustainability impacts of utilising cereal grain for conventional bioethanol production, or cereal residues or Miscanthus for 2nd generation biofuel production. This will performed using life cycle assessment (LCA) to compare the environmental impacts of crop production, processing and delivery to a bioethanol plant. The role of cereal residues for nutrient recycling and soil quality will be assessed, as will the ability of LCA to take these roles into account. The research will help to identify whether cereal residues should be considered as a co-product or a residue in LCA methodology. Effects of land use change for Miscanthus will also be examined,

including changes in carbon stocks after land conversion and throughout the crops life cycle. The opportunity cost of carbon is also included, which examines the longer-term carbon storage potential in energy grasses if left to grow. The knock-on impacts on land conversion due to of displacing wheat production for Miscanthus, or using wheat for fuel rather than food, will also be considered.

Renewable energy resources

Keynote presentation

SDWS2012.0249 Potential Planning Method for Supplying Energy Plant with Renewable Forest Fuels

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Abstract

In this study, a potential solution to renewable fuel procurement scheduling problems is considered. The CHP plant's problems include the allocation of a number of electricity, forest, fossil, peat, and wood-waste fuel procurement chains to an energy plant during different periods. InFinlandpeat is commonly used as a fuel of energy plants. However, it is recently considered as a non-renewable fuel. Therefore we tested the developed scheduling method using Finnish government's peat tax policy decisions for sustainable energy production. We used a dynamic linear programming model to describe the scheduling task and solved it by an adaptive optimization technique. However, due to the complex nature of the renewable fuel-procurement problem, the resulting model cannot be directly used to solve the multi-objective problem in a manner that is relevant to the forest industry. Therefore, this approach was combined with an energy-production model to better describe the combinatorial complexity of energy flows. The properties of this methodology are discussed and we present three examples of how the model works based on real-world data, forest technology rate and optional peat-tax constraints. They allowed us to assess the impacts for the industry of including the peat tax cost and various forest technology rates. The methodology can be used as a powerful core for future decision-support systems, and has high potential to significantly improve the information logistics in respect to the procurement planning of renewable energy-fuels.

SDWS2012.0045 Mapping the High Altitude Wind Energy in Southeast Europe

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Abstract

High altitude winds are considered to be, together with solar energy, the most promising renewable energy source in the future. Till date, there are no yet solutions available on the market but various concepts for utilizing high altitude winds are under research and are expected to be fully operational within next few years. In this paper, the potential of high altitude wind energy will be investigated for the Southeast Europe region and mapped using available data and technologies. The data available from NCEP/DOE Analysis will be used in terms of obtaining the high altitude wind speeds for the last 5 years which are then processed for easier visualization. The result of this work points out the "optimal" locations for these kinds of facilities for each country in the region. Such map could be beneficial for all future plans of utilizing this energy source.

SDWS2012.0063 Evaluation of Environmental Acceptability for Biomass Plants

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Abstract

In consideration of local critical impact aspects in opposition to overall environmental benefits (decrease of GHG generation) for energetic plants operating on biomass, the aim of this work has been, as an example and an indication of methodology, a verification of the local acceptability as concerns the air quality in the interested territory; the plant, to be constructed in a small town located in Piedmont, northern Italy, will be devoted to produce electricity first of all, but also potentially heat. In order to verify the compatibility aspects we performed an evaluation of the total emissive flows modification that the hypothesis of the new biomass plant activation should introduce in the municipal area. We considered, in comparison with the new emission flows resulting from biomass plant activation, and by considering different scenario hypothesis, the avoided emission flows resulting from turn off of the currently active thermal boilers, that the implementation of district heating system could eliminate. The different considered scenario hypotheses

correspond to different estimations of capacity of connections of houses to district heating network. As concerns the calculation scheme, the evaluation has been conducted by using the tools of mass and energy balances, the emission factors and finally an externalities balance. The results of the comparison between introduced emissions and avoided ones highlight, with different weights between the different scenarios, but with an almost general result, a significant increase of the emission flow, in particular with regard to nitrogen oxides and dust parameters. The result chiefly originates from the low valorization potentiality of the cogenerated heat flux by using district heating solutions. The increased emission flow leads to worsening in the air quality, and therefore it is very important to evaluate the expected changes and their consequences. By using meteorological predictive models it is possible to identify an increase in pollutant concentration (in particular for the above-mentioned parameters) in the areas strictly near to the plant. The increased emission flows and consequent air quality worsening should be evaluated not only with reference to law limits, but also by considering the hypotheses for the development of the municipal territory. From this point of view, chiefly taking into account the indicated low capacity of utilization of cogenerative options, the conclusions that can be derived from the work highlight the strong presence of local incompatibility aspects, in opposition to general benefits as concerns renewable resources utilization and climate change limitation. These considerations, numerically defined for the specified studied case, can be considered quite representative more generally for the perspective of energetic biomass plants.

SDWS2012.0190 Comparison Among Different Bioenergy Chains in the European Context Based on Their GHG Saving Potential

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Abstract

Biomass fuels are a potential source of renewable energy but concern arises about their environmental sustainability. The greenhouse gas (GHG) emissions produced in the life cycle of a biomass fuel can be an important indicator of the environmental evaluation of energy production. The GHG emission saving originated by displacing traditional sources of energy was adopted by the European Directive on the promotion of the use of energy from renewable sources and by the European report “from the Commission to the Council and the European Parliament” on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling.

In this study, different electricity production chains from biomass were evaluated in several European contexts, based on utilization of biogas, crude vegetable oil and solid lignocellulosic biomass in 1 MWe conversion plants.

Different energy production scenarios (S) were defined for each bioenergy chain. For biogas production two feedstocks were considered: maize silage (SB1) or animal slurries (SB2); crude vegetable oil was supposed to be produced from inland cultivation of rapeseed (SO1) or from palm oil imported from South East Asia assuming either the cultivation on long term cultivated cropland (SO2) or land use change from rainforest to cropland (SO3). Regarding solid biomass, the considered feedstocks were produced from mischantus plantations (SL1) or from short rotation forestry (SL2), in both cases considering partial heat recovery for household use. For each scenario, emissions of primary energy production were estimated following an LCA approach by considering emissions associated with feedstock cultivation or exploitation, storage, transport and processing. GHG saving at conversion was estimated considering as reference energy system the grid electricity mix, specific for each examined member state and results were compared.

All scenarios showed good GHG emission saving, except for palm oil. Indeed, in spite of high yields and optimized levels of processing efficiency considered, in SO2 the high level of emission observed was due to maritime transport to Europe, and in SO3 a further source of emissions was due to the carbon stock loss following land use change. Regarding the emissions associated with primary energy production, the remaining scenarios differed mainly in biomass cultivation or exploitation impacts.

Concerning GHG saving of produced electricity, differences were also observed among considered member states due to different carbon intensity of the grid mixes.

SDWS2012.0282 Comparison of Different Solar Radiation Estimation Methods Used in Solar Energy Resource Assessment

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Abstract

Accurate estimation of solar energy resources in a country is very important for proper siting, sizing and life-cycle cost analysis of solar energy systems. Measurement taken at ground weather stations can be used, however, since the number of these stations is limited, it won't be possible to conduct an accurate assessment of the solar radiation in locations far from these meteorological weather stations. To solve this problem, a variety of approaches using satellite measurements and simulations which are based on different numerical models are commonly used. This paper presents a comparison between the most widely used models based on a case study. The most commonly used method was based on satellite measurements. However, recently, new simulation models were introduced and implemented in Geographical Information Systems (GIS) or in Numerical Weather Prediction (NWP). For this study, a dynamical downscaling approach using the COSMO NWP Model at 2.8km was adopted. A comparison between ground measurement and Satellite data, GIS simulation and NWP model results applied to a study case has revealed that the NWP model is the most accurate because of its dynamic nature taking into account the state and the physics of the atmosphere. It was also noticed that the results obtained by the GIS model were more accurate than the satellite data because of the coarse resolution of the satellite data while the GIS model was run on higher resolution digital elevation maps taking into account the topographic parameters in the calculation of the total solar radiation.

SDWS2012.0312 Private Forest Owners Play Key Role in European Forest Derived Fuel Utilisation

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Abstract

With over half of the forested area of Europe in the ownership or operation of private forest owners are an essential stakeholder in increasing woodfuel utilisation.

Nine European organisations from six countries launched an EU funded "Activating Private Forest Owners to increase forest fuel supply" (AFO) project, with the aim to meet ambitious targets for increased energy from wood utilisation. The project is part of the IEE programme and ends in September 2012.

The challenges of mobilising woodfuel reserves in privately owned forests are replicate in most European countries, allowing the projects results to be circulated widely. Forest owner surveys in AFO target regions (UK, France, Latvia and Slovenia) identified the following challenges for enhancing woodfuel supply from privately owned woodlands. First, forest holdings are small and becoming more scattered. Second, they belong to a diverse and urbanising group of owners. Third,

due to their small size, the forest holding is not considered to be an actual investment, it is under-valued, and therefore not expected to generate revenue

The AFO project aims to 'activate' forest owners into management activity in their woodland, bringing increased timber supply to market. It aims to identify and then help reduce the barriers for increased forest derived fuel supply. It identifies the potential supply and demand opportunities, along with supporting the formation of woodfuel clusters consisting of owners, managers, agents, contractors, users and suppliers and assisting in the organisation of supply chains. Work is taking place through a series of local workshops, regional study tours, face-to-face meetings, dissimination of best practice and training weeks in countries of high woodfuel utilisation (donor countries); Austria and Finland.

The AFO project has allowed forest owners, operators and managers to hear and see at first hand successful woodfuel supply chains and business models that operate or could be replicated in their own country and in partner countries. Instead of relying on theoretical concepts, the project has also provided costed, market proof examples, which is, vital to ensure successful implementation. AFO has brought different stakeholders together, removing suspicion and building bridges to create new business opportunities. Cluster

formation can effectively reduce overhead costs, open new markets and allow forestry works to be cost affectively undertaken.

Energy system analysis II

Keynote presentation

SDWS2012.0309 EINSTEIN – Methodology and Software Tool for Advanced Energy Audits in Industry

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Abstract

Significantly increasing energy costs and defined energy targets in the European Union encourage industrial companies, consuming more than 27% of the total energy in the EU27 in 2008 to reduce their energy consumption decreasing costs and CO_2 emissions. Therefore, sometimes cost and time consuming energy audits are carried out with the danger to determine only limited potentials of energy savings. To ensure a high level of quality of fast-audits with the target to identify the potentials of energy saving measures EINSTEIN an open-source software tool for energy audits has been developed within several European (Intelligent Energy Europe – IEE) and national projects. By standardised audit steps and highly developed algorithms and methodologies the claimed targets could be achieved proven within more than 150 energy audits carried out.

The EINSTEIN software and methodology is suitable for producing companies and large buildings (sport centres, hospitals...) with a thermal energy demand. The first step is modelling the present state of the company based on information received from the company and data collected during a visit on site. Results are displayed as e.g. primary and thermal energy demand split by processes and temperature level and compared to benchmark data.

Based on the present state production processes and their energy demands are evaluated and possible potentials of a process optimisation are detected. Following is the design of a heat recovery network that can be done manually or automatically supported by a design assistant based on algorithms part of the software. The last step is the implementation of renewable energy as solar thermal for the generation of heat and cold as well as the integration of more efficient technologies. Hence the efficiency of the company can be increased and energy consumption and costs can be decreased significantly.

Several alternatives and the present state can be compared automatically to each other (ecological, energetical and economical). The best solutions with the highest potentials for cost and energy savings are chosen and displayed in an automatically generated report. In the paper an overview of the performed 150 audits in Europe will be presented as well as

some best practice examples will be described in more detail. EINSTEIN is open source and downloadable for free. Users are supported by an audit guide including helpful examples as well as trainings offered all across Europe.

SDWS2012.0198 Quality of Living and Related Sustainability Indicators – Case Study City of Ljubljana, Trends up to 2050

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Abstract

The greatest challenge of the future development of urban areas has been related with the sustainability issues. Unfortunately, sustainability issues and costs of resources, including energy occupy minds only of minority in the society. Most of the people tend not to see or feel direct links between their actions and environmental performance. Future quality of living in urban areas is directly linked with the successful transition toward low carbon society. In the process of transition toward low carbon society many countries set indicative targets which are revealing desired momentum of change but only on the national level. On the other hand, cities (local level) are responsible for around 75% of the world's energy consumption and for almost 80% of the world's CO2 emissions. The absence of the clear and direct transformation of national targets into implementation programs on the local level was the crucial reason why many goals have not been achieved. As long as there is no transformation of national targets into implementation programs on the local level there will be no solid basis to boost motivation and willingness for a change on the local level. Within the paper five main sustainability indicators related with the quality of living in urban areas have been described and discussed. Indicators have been tested and customised during the analysis of future development challenges of the Slovenian capital, City of Ljubljana. Results of the analysis show that suggested indicators may be used in the verification follow-up program and also within the prediction engine. Within the analysis technology and sector oriented bottom up model of reference energy and environmental system of City of Ljubljana has been developed. It is the first so complex reference energy and environmental system that has been developed on the municipal level in Southeast Europe.

SDWS2012.0317 Improvement of Combustion Efficiency of Pulverised Coal with Under-Fire Air Introduction

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Abstract

Optimisation of air and fuel introduction in utility boilers is very important for improvement of their energy and environmental performances. Advanced mathematical methods offer opportunities for an in-depth analysis, optimisation and examination of various options in order to increase the overall efficiency of the energy facilities. The objective of the present work was to analyse the effect of air redistribution as a consequence of the under-fire air introduction, on the flow field, temperature profiles and combustion efficiency in a utility boiler, with implementation of lower air introduction through ports located at the bottom of the furnace. The mathematical framework of the research is described in the paper. Computational fluid dynamics (CFD) modelling technique is extensively used for investigation of the aerodynamic behaviour of the gas-solids mixture, combustion efficiency, temperature profiles and gaseous combustion products concentrations in a case study of a utility boiler of 225 MWe power plant unit. The numerical domain of the object under consideration represents the boiler furnace and a part of the convective tract, and the numerical grid consists of 1427987 volume cells. The modelling results are compared with a test matrix of measurements at different boiler operating conditions. The main parameters that were changed are: air flow distribution, boiler load and burners load. Comparison between the numerically obtained and measured temperature profiles, as well as energy loss due to inefficient combustion shows satisfactory compliance. The analysis of the results concerning the near-burner regions indicates the occurrence of intensified swirl and improved combustion efficiency, as under-fire air flow rate was increased.

SDWS2012.0258 The Nickel Foam as the Electrodes Material for an Alkaline Electrolyser

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Abstract

The alkaline water electrolysis process using renewable energy sources allows hydrogen production completely with zero CO_2 emission. Also, hydrogen used as a fuel for transport vehicles or energy storage, produces only water and no other harmful emissions. In that sense, alkaline electrolysers can play important role in sustainable development of the transport and power sectors. Consequently, electrolyser efficiency needs to be permanently improved. On the increasing of electrolyser system efficiency, the large impact takes material of the electrodes. In investigation of the different materials for hydrogen production, nickel (Ni) foam has shown wide interest in hydrogen scientific community. In this paper were performed experiments both on the Ni foam and Ni plate with aim to improve the system efficiency. The electrolyte in all performed experiments was 25% potassium hydroxide (KOH) solution. The measurements were done in the aim to define parameters of the electrodes such as parameter related to Ohmic resistance of electrolyte and coefficient for overvoltage on electrodes as well as effect of the electrodes active surface area on hydrogen production. An active surface area of the Ni foam was calculated via BET method. Hence, there was defined linear region of the hydrogen production. Furthermore, there was shown that an increasing of the electrodes overvoltage decreases the resistance to the charge-transfer both at the Ni foam and Ni plate but according to the active surface area calculation, hydrogen production is much higher using Ni foam electrodes in comparison to the Ni plate at the same overvoltage. The results were presented in diagrams and tables.

SDWS2012.0344 Potentials for Energy Savings Through Drinking Water Well Field Optimisation

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Abstract

With rising energy prices and global climate change, the question of the energy efficiency of drinking water production becomes more and more present. In general well field optimization is seldom being used to minimise energy costs for groundwater abstraction. However, optimizing pump design and well field operation could significantly reduce the energy demand and costs associated for the well field operation. The large number of involved decision parameters for well field management (e.g. number of operation configurations) adds to the complexity of an optimizing approach, requiring adequate tools for addressing this issue.

In this study, the key energy demand drivers were identified and quantified for a French well field. As a result the geometrical elevation (difference between static groundwater level and waterworks elevation) was the identified as most important driver. Pipe network losses were in the same order of magnitude as aquifer- and well losses. The specific energy demand of the well field was best correlated with the overall discharge for the current operation scheme, with a smaller significance of the share of operating hours per well.

A coupled modelling tool (able to simulate well drawdown, pumps, pipe network) was developed and tested for the well field with input parameters derived from data analysis and an site audit. While the data-driven approach (statistical modelling) mostly succeeded in analysing the energy drivers, the process-driven approach (hydraulic modelling) enabled to calculate potential energy savings if the operation of the well field is modified to reduce its energy demand. In this context and for the specific well field, cost savings of up to 20% can be achieved just by optimising the well field operation without investing in new pumps.

These findings show the potentials for energy and cost savings in the field of drinking water abstraction. However, additional boundary conditions (e.g. water quality) need to be considered to ensure that well field operation with the highest energy saving potential is in line with restrictions or constraints (e.g. water quality) water supply managers are facing.

SDWS2012.0337 An Alternative Solution for Fuel Switching According to the SEEU CAP

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Abstract

In the realization of the SEEU CAP fuel switching is one of the activities for emission reduction and energy efficiency. The system is currently fuelled with heating oil, a highly pollutant fuel. Alternative fuels may result in fuel savings and above all, a notable emission reduction. Three possibilities have been compared to heating oil: natural gas, LPG and biomass (wood chips). Among the fossil fuels, natural gas has the highest potential in terms of emission reduction and fuel consumption.

In this paper is analyzed the alternative solution, the installation of a CHP (micro-turbine) system for the combined production of electricity, heating, cooling and sanitary hot water. The system is based on a micro-turbine fuelled with natural gas. It is shown that this alternative solution for fuel switching has advantages in emission reduction, energy efficiency, secure power demand, power quality, reduce energy costs, conservation of valuable fuel resources and prompt payback on investment.

GHG emissions

Keynote presentation

SDWS2012.0299 Carbon Footprint Management in Office Based Companies

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Abstract

Offices contribute for a large part of carbon emissions and climate change in the world. Approximately 19% of all commercial energy consumption is in office buildings. 70% of office building energy is electricity, which is used for lighting, heating, cooling and office equipment. More than a quarter of carbon emissions are associated with the employees' travelling for office related business.

This paper examines carbon footprint of Vestel Company, a software development and information technology company based in Skopje, Macedonia which has a goal of becoming social responsible, environmental and sustainable "Green IT" company. In-depth analyses of the company's activities have been conducted in order to assess the emissions, as well as to propose a pertinent action plan for company's carbon footprint reduction. The preliminary results have shown that the annual emissions of the company, estimated to 20 t can be reduced for 7 % if the proposed mitigation measures are implemented.

Using the case of Vestel Company as a good example, the paper further investigates how some techniques for social marketing can be applied in order to motivate other service companies to alter their views and behaviour towards lowering their carbon footprint, recognizing thus the consumer's mind-set for climate change and the environment as a business reality for sustainable growth.

SDWS2012.0331 Greenhouse Gas Emission Mitigation Scenarios Up to 2050: Modeling of Policies and Strategies for Belgrade

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Abstract

The production and use of fossil fuels for generation of heat and electricity, in households, industrial processes and transport in urban areas raise significant environmental problems. There is a need for assessment of the greenhouse gases emissions (CO2eq) and identification of mitigation actions. This paper analyzes the inventory of CO2eq in Belgrade, as the capital city, in which the energy consumption reached the highest level in many sectors of consumption such as household, public sector, traffic and industry. The total emission of CO2eq in Belgrade is calculated and based upon the data established on the total consumption of electricity, heat and all types of fossil fuels for all sectors of energy consumption in the city in 1990 and 2006. The projections of energy consumption and emissions of CO2eq are calculated for 2025, on the basis of an established methodology which results in systematic connection of specific energy needs with a set of social, economic and technological factors. In order to reduce the emissions it was necessary to determine possible mitigation scenarios. In this paper three such scenarios which predict CO2eq emissions levels by 2050 are outlined and compared. The first of them is the scenario "business as usual". This is the basic scenario which assumes that the technology being currently used to produce electricity and heat does not change by the year 2050. On the other hand, both scenarios 1 and 2 are based on the use of new technologies as well as on renewable energy sources. Joining the European Union and adoption of the energy and climate acquis will be the main drivers for GHG mitigation in the energy sector in Serbia over the coming years. The EU Energy Road Map documents for the year 2050 will be a key reference document for Serbia's long-term objectives in the energy sector. Scenario 1 considers a program of technological modernization of energy systems, rehabilitation of existing power plants and heating plants, increase of energy efficiency and the additional electricity and heat generation using renewable energy sources. The net effect of these mitigation policies and measures are assumed to lead to CO2eq emissions levels in 2050 which are only somewhat higher than in 1990. Scenario 2

assumes that the main driving force in GHG mitigation will be a significant rise of the price of electricity, i.e. achieving a realistic, market driven parity of prices of electricity and other energy sources. This will in effect enhance the mitigation outcome of practically the same policies and measures considered in scenario 1 and thus leading to somewhat lower CO2eq emission levels in 2050 compared to 1990.

SDWS2012.0529 CO_2 Linkage Effects of Taiwan's Electricity Sector by Input-Output Analysis

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Abstract

Electricity has played a critical role in supporting industrial development and economic growth in Taiwan. In this study, linkage effect analysis is used to evaluate the inter-industry relationships of the electricity sector among a 42-sector input-output economic system in Taiwan. The sensibility index of dispersion and the power index of dispersion are calculated to measure the forward and backward linkage effects. In addition, the CO2 multipliers of the electricity sector from fossil fuel combustion are calculated to identify the differences of direct and indirect CO2 emissions intensity. Results indicate that economic growth had the dominant impact on electricity use; artificial fiber, coal products and cement were among the top CO2 intensive sectors related to electricity sector in Taiwan. Because of its linkage effects, it would be an underestimation of GHGs effects if the indirect CO2 emissions from the related sectors in the input-output table were omitted from the calculations. Results can be of value for prioritizing CO2 reduction strategies and related energy policy for electricity sector.

SDWS2012.0196 The CCS Technical Viability Application in Coal-Fired Power Plants Situated in Northeast Brazil: an Water Consumption Case

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Abstract

CCS is a mitigation action that has been largely researched and tested to have the application disseminated in bulk emissions sources such pulverised coal-fired power plants. Brazil has expanded its coal-fired power generation, mainly in the Northeast, where three pulverised coal power plants owned (at least partially) by MPX are in the construction phase: Porto de Itaqui, Pecem I and Pecem II. It is acknowledged that the CCS application on pulverised coal-fired power plants can arise their water consumption by up to 96% (NETL, 2007). The hydrographic region where the three new power plants will be built is considered the Brazilian region with the lowest hydraulic availability. So the main aim of this research was to assess the technical availability, from the water availability point of view, of CCS implementation in these power plants. To assess it the paper is divided in two main sections. The first one allows comparisons between the power plants water consumption with and without CCS, based on simulations results ran within IECM software. The second section presents ratios to measure the hydraulic vulnerability in the sub-basins which will serve as water source to the new power plants. When CCS is implemented at Porto de Itaqui power plant simulations results show make-up water increases 109% and water consumption arises113%. Make-up water increases 105% for Pecem I and Pecem II when CCS is implemented at these plants. Pecem I and Pecem II water consumption rises 104% as a consequence of CCS installation. Such results are compared on a net energy basis and the capture system considered is an amine-based one. While the water demanded by Itaqui power plant will be pumped from São Marcos Bay and, therefore, will need to be desalinized before use, the source of water for Pecem I and Pecem II will be nearby açudes along with the Gavião-Pecem canal, which has been built and will get water from Medio Jaguaribe sub-basin. Even not considering CCS implementation at these plants, a government report argues that this water captivation system will need to be expanded to supply all water demand to the port and industrial park where these power plants will be built. The ratios between water demand and accumulated average flow for the sub-basins which will be source of water to the Pecem I and Pecem II power plants show the importance of the canals that are being constructed to get water from the Medio Jaguaribe sub-basin, since the current water supplier sub-basin hydraulic availability is considered critique. On the other hand, since the currently planned canals to complement the future water demand in the industrial park where the power plants will be situated will not supply enough water, the expansion of the

system will need to be over estimated to allow CCS inclusion in the future. For the Porto de Itaqui power plant it is important to emphasize that the CCS implementation tend to double its water desalinization costs.

SDWS2012.0290 Benefits of Using Molten Carbonate Fuel Cells for CO_2 Capture in CHP Plants at Wastewater Treatment Facilities

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Abstract

Reciprocating gas engines are commonly used to generate heat and electricity in wastewater treatment plants where they are operated on the biogas fuel produced from water sludge in anaerobic digesters. Heat is almost entirely used to support the endothermic anaerobic digesters whereas part of the electricity is used to power the equipment in the plant. The remaining electricity is exported to the grid.

The present work analyses the potential of reducing the CO2 emissions in these cogeneration plants by incorporating a Molten Carbonate Fuel Cell into the engines' exhausts. These devices (MCFCs) have already been used to generate heat and power at cogeneration plants; as a matter of fact, there is even a pilot plant in Tulare, California, for the particular application in wastewater treatment facilities. Nevertheless, the novel approach of this paper is the use that is made of the MCFCs since the fuel cell is not used to oxidise biogas directly but to act as an active carbon capture system. That is to say, exhaust gases from the engine are conducted to the MCFC's cathode where carbon dioxide is conveyed through the electrolyte to the anode. Hence, only a mixture of water steam and carbon dioxide, along with the excess hydrogen fuel, is present in the anode's exhaust. It is so deduced that in the proposed configuration the usual CO2 recirculation from the anode exhaust to the cathode inlet can be eliminated if enough CO2 is supported to the cathode by the engines' exhaust gases. In addition, the fuel excess in the anode exhaust is burnt separately from the cathode exhaust (rather than burning the mixture of both) in order not to dilute the carbon dioxide already captured. An Air Separation Unit (ASU) is used to provide the oxygen required.

The aforedescribed layout rise to a relatively inexpensive separation by a water condensation process that largely reduces the carbon footprint of the entire system. Also,

it is worth noting that the MCFC is in charge of the CO2 capture process but, at the same time, generates electricity. In consequence, the system reduces the energy demand for CO2 separation with superior efficiency compared to conventional postcombustion techniques, reducing the specific carbon footprint dramatically without disturbing the wastewater treatment process at all. Moreover, an additional by-product is found in the carbon emissions saved which can then be traded (potentially). The optimal design and operating conditions and the economics of the proposed plant are analysed for different scenarios considering: market conditions, technology readiness and plant scale.

SDWS2012.0206 Minimum Work of Separation and Learning Curves for Carbon Capture Based on Chemical Absorption

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Abstract

The scientific literature has recently emphasized carbon capture as one of the most important alternatives for mitigating greenhouse gas emissions. The most studied case is the retrofitting of existing thermal power plants, which is usually based on the chemical absorption of the CO_2 diluted in the flue gas. Essentially, all capture processes presents an increase of the final energy consumption. This energy penalty can be considerably high for capture purpose and typically, in post-combustion capture plants, the regeneration of the solvent is responsible for the most part of it. Therefore, in order to compare the various capture processes available, it is worth estimating the minimum energy required to capture the CO_2 emitted. This study estimates "minimum work of separation" (**MWS**) as the lowest amount of energy required to promote the separation of one or more components of one or more mass flows. After estimating MWS, the study analyzed the difference between the performance of real absorption solvents and the MWS. Then, the study proposed a learning curve for the carbon capture plant based on the chemical absorption process. The findings of the thermochemical analysis showed that the separation of 90% of the carbon dioxide in the flue gas presented a MWS of 0.158GJ/t. This figure is much lower than those found for real plants, showing that there is an impressive potential for improving the performance of this process. For instance, the conventional process (MEA), presents a regeneration energy that hovers between 7 and 8 times greater than the MWS. Among the most advanced processes found in the literature, the DMX and Chilled Ammonia, this relation is closer to 4. Therefore, the gradual evolution in the development of both solvents and process integration are crucial to the implementation of CCS. However, as of today, it is difficult to forecast the costs of the

chemical absorption process, given the information available and the uncertainties related to the investments in first-of-a kind plants. Lately, the use of learning curves have been proposed. Based on the data collected and the MWS, this study adjusted the parameters of three learning models for capture plants: exponential, or Wright model; DeJong model; D&L model. The DeJong and D&L models show a major advantage, since they allow the establishment of a threshold value, constrained by the MWS. As a result, the D&L model, proposed in this paper, provided the best fit among the models used. Finally, the LR determined in this study was 23%, which matches the figures of the literature.

Energy economics/ Externalities

Keynote presentation

SDWS2012.0188 Does it Pay to Be Clean? Evidence from the Global Renewable Energies Equity Indexes

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Abstract

The growth of Renewable Energies equity indexes around the globe has resulted in demand from investors, institutions, and other stakeholders for rigorous scientific research on the financial outcomes of investing in companies engaged in the manufacturing, development, distribution, and installation of clean-energy technologies such as wind power, solar photovoltaics, biofuels and fuel cells, among others. In response to that need, we analyze the financial performance of the most relevant Renewable Energies equity indexes at a global context and it is compared with the achieved by their market benchmarks. This study represents, on the best of our knowledge, the first attempt to asses the risk-return performance of this type of investment, focused on public companies whose activities demonstrate the greatest potential for mitigating immediate and long-term causes of climate change. In addition, this paper introduces a methodological innovation and applies a state-space Capital Asset Pricing Model in order to allow Renewable Energies equity indexes systematic risk to vary over time. This provides crucial information for carrying out accurate active investment strategies. The main results indicate that, in general, there are no risk-adjusted returns penalties as a consequence of investing in these environmentally-oriented equity indexes. Furthermore, the risk levels experienced by the Renewable Energies stock indexes are lower than the obtained by their benchmarks. This result refutes the principles established by Modern Portfolio Theory, which predict negative financial consequences of investing in Renewable Energies Equity indexes and Socially Responsible Investment in general. In this line, the results of this work do not support the frequently expressed hypothesis that there is a risk disadvantage of investing in alternative clean energies resources. These results have some important implications both for investors and the stakeholders in general because they have the opportunity to fit their ethical values and principles with their investment strategies without being financially penalized and contributing to the environmental preservation and social well-being.

SDWS2012.0349 Green GDP Accounting – Determination of Direct and External Energy Related Costs of Economic Development

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Abstract

Main objective of this paper is to detrmine, identify and analyse efects that costs of CO2 emission have on GDP. CO2 emission represents main global negative consequence of energy exploitation. Current economic analysis are pointing out the costs of CO2 emissions, if not monitored and not reduced, affecting the energy sector and could cause an environmental damage, and thus may contribute to further destabilization of the economic system. Question arises, about emissions and their impact projected on economic growth. Manuscript will determines trends in CO2 emissions costs, and their impact on GDP, as basic economic parameter. Final outcome of manuscript is determination of total energy related costs of economic development. Results shows significant differences among EU27 states. Most developed EU countries recorded between 10 and 13% of GDP as energy related, most EU27 countries shows ratio between 14 and 22, but 3 countries recorded high level – between 23 and 29%. Worst situation is determined in new EU members. Research covered period between 2000 and 2010 and results showed different changes regarding these costs. In some countries, level is the same as in 2000, but in some countries level arises or dropes in the same period of time. Economic development is not recorded as only driver of changes in energy consumption. Additional explanations and future trends in area of energy related costs of development are also presented.

SDWS2012.0352 Environmental Taxes as Parameter of Sustainable Development Metrix – Parameter of Strategic Control of EU Strategy 2020 Implementation

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Abstract

The main objective of paper is to determine the importance and impact of environmental tax collection on economic and ecological development in the EU Member States. Environmental taxes that result from carrying out economic activities on the overall development can act in two ways. From the aspect of companies, environmental taxes are costs, but from the aspect of society, it represents income. The work represents an attempt to determine such a diverse way of measuring the impact of environmental taxes, as well as predicting future trends in this area. Environmental taxes, except that represent economic indicator, are seen as a financial legal category that largely determines the position of the company, and thus influence the changes in the movement of macro-economic indicators of development. The result of this work represents the analysis of the policies of collection of environmental taxes in the EU27, as well as analysis and measurement of mutual relations between the indicators of sustainable development that are most directly associated with environmental taxes. Highest volume of collected taxes is recorded in Germany and in France.Results also shows changes during last ten years regarding environmental taxes as part of GDP. In the same time, control of environmental taxes spending is not enough transparent in all EU countries, and that represents significant problem for European Commission - monitoring system as a whole. Manuscript suggests possibilities for improvements and predicts future changes in this area.

SDWS2012.0199 Wind Power and Employment in Brazil

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Abstract

Investments in renewable energy and climate change mitigation go beyond the reduction of greenhouse gases emissions. Secondary benefits include technology transfer, reduction

of emissions of other pollutants, and job creation, often called Green Jobs. It is known that job creation reflects on social, economic, environmental and territorial aspects. Therefore, job creation can be an indicator of social performance of energy projects.

Wind power has experienced expressive growth in the past few years, and contracted wind projects will increase Brazilian installed capacity from 1.4 GW, from the end of 2011, to 7.3 GW by the end of 2014. The preset article aims to evaluate the consequences of this rapid growth to the job creation in Brazil. Direct jobs were quantified in the manufacture, installation and operation of 200 MW, observing national characteristics and national manufacture of major components. Also, indirect jobs were calculated using an input-output matrix, based on resources and raw material consumption for manufacturing and construction.

Preliminary results show that the estimated wind power growth will generate 41,450 direct jobs, plus 78,880 indirect jobs over the economy, totalizing over 120,000 total jobs in this three-year period. Over 40% of direct jobs are created in the construction stage, which has high level of local employment, bringing social and economic benefits where the projects will be installed. It is important to highlight that these figures are only valid if raw material and major components are produced in Brazil. However, the reduction of wind power prices achieved in competitive auctions, from US$ 84.60 in 2009 to US$ 63.85 in 2011, may lead to the import of materials, such as steel, which accounts for 70% of indirect jobs.

Wind power's rapid growth can have an important impact over the employment in the Brazilian economy. However, to achieve the benefits of job creation, the national industry must be strengthened and there must be incentives for the consumption of national raw materials, in particular, steel.

SDWS2012.0157 Energy Efficiency Projects and Local Budget: from Lacking Revenues Towards Successful Story for Sustainable Future

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Abstract

In the theory the public sector is a crucial actor in promotion and implementation of energy efficiency measures. In Croatia this sector has just started to implement cost-

effective measures which will generate energy and expenditure savings. This paper focuses on the successful examples of Croatian cities and counties that have implemented project (energy efficient public lighting, energy efficient projects in public buildings, efficient water use, sustainable wastewater management and sustainable waste management) in order to develop sustainably. The objective of this paper is to demonstrate not only financial savings achieved in the local budgets as a result of the implemented energy efficiency projects, but also to point out effects of these projects on life quality in selected cities and counties in Croatia. In order to fulfill the goal of the paper, after the introductory explanation, the second part describes the basic types and characteristics of energy efficiency projects undertaken in selected Croatian cities and counties. Third part of the paper elaborates the correlation between local budgets and energy efficiency projects. The focus is to explain how improved energy efficiency projects will result in reduced energy related expenditures, hence reduced overall annual expenditures in local budgets. To provide more evidences, structure of selected local budgets by economic and functional classification for period 2002-2010 is given. Correlation between implemented energy efficient projects and local budget is presented in the fourth part of the paper. Based on the data availability, performance indicators for measurement of achieved results and outcomes at local and county level are defined. Instead any conclusion, the results presented in this paper will serve as a good example for other local and regional self-government units inCroatiaby providing a detailed insight in characteristics of energy efficiency projects, cost and financial savings and their relation to successfulness of local sustainable development. Finally, recommendations for efficient and sustainable development local policy are presented.

SDWS2012.0059 Modelling Gas Storage with Compressed Air Energy Storage in a System with Large Wind Penetrations

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Abstract

Installed wind capacity in the European Union is expected to continue to increase due to renewable energy targets and obligations to reduce greenhouse gas emissions. Renewable energy sources such as wind power are variable sources of power. Energy storage technologies are useful to manage the issues associated with variable renewable energy sources and align non-dispatchable renewable energy generation with load demands.

Energy storage technologies can play different roles in electric power systems and can be used in each of the steps of the electric power supply chain. Moreover, large scale energy storage systems can act as renewable energy integrators by smoothening the variability of large penetrations of wind power. Compress Air Energy Storage is one such technology. The aim of this paper is to examine the technical and economic feasibility of a combined gas storage and compressed air energy storage facility in the all-island Single Electricity Market of Northern Ireland and the Republic of Ireland in order to optimise power generation and wind power integration. This analysis is undertaken using the electricity market software PLEXOS ® for power systems by developing a model of a combined facility in 2020.

Energy markets

Keynote presentation

SDWS2012.0425 The Looming Revolution: How Photovoltaics Will Change Electricity Markets in Europe Fundamentally

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Abstract

For a long time Photovoltaic systems has been seen as an environmentally benign technology with a huge potential yet very high costs for electricity generation. In recent years the costs of PV systems in several countries – withGermanyleading – decreased remarkably due to significant increases in capacities. These increased PV capacities have since 2011 on some days significant impacts on spot market prices at the German electricity exchange EEX. In this area in the next years at least a continuous further growth of PV capacities can be expected. InGermanyonly it is expected that total installed PV capacity will increase from about 20 GW (installed by the end of 2011) to at least 50 GW by 2020. This is half of total fossil and nuclear capacity inGermanyin 2011. Moreover, the looming grid-parity will further emphasize this trend because PV will become economically more attractive. The core objective of this paper is to analyze the possible effects of this uptake of PV on the prices in the German-French-Austrian-Swiss electricity market. Moreover, of specific interest is the likely competitiveness of PV due to "grid parity" – leading to lower costs of PV than the household electricity price is. The perceptions and conclusions of this analysis can be used in many countries world-wide. The method of approach applied in this work is based on a fundamental approach where the intersection of supply and demand at every point-of-time gives the corresponding market price. Furthermore we compare PV costs with household electricity prices to identify grid-parity prospects. For modeling household electricity prices also the future costs for grid, storage and balancing energy are considered. The major effects of these developments on the electricity markets will be: (i) a much higher price volatility from hour-to-hour and day-to-day; (ii) increasing relevance of intra-day markets; (iii) higher costs and prices for fossil capacities (due to higher shares of investment depreciation costs); (iv) increasing relevance of storages and "smart" grids; (v) higher incentives for PV owners in households for own use of electricity; (vi) balancing markets will gain higher market shares; (vii) finally the complexity of managing supply, storages and demand will increase continuously over time. (viii) Regarding the final electricity price

for customers the share of costs for auxiliary services will increase remarkably compared to the pure energy production costs. The final conclusion of this analysis is that in the next years a fundamental change in the way electricity pricing and supply for household is designed.

SDWS2012.0030 The Influence of Internal "Self-Balancing" on the Operation of a Power System

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Abstract

Today, the power system in Norway and the north of Sweden is dominated by hydro power while in southern Sweden and Finland thermal power generation is significant. Wind power does not yet play a major role in electricity generation in these countries. Nevertheless, the plans for its deployment in Sweden are ambitious, and the number of wind farms is increasing. This development contributes to a less polluting and more sustainable power generation, but it also raises challenges for the operation of the power system. One example is short-term fluctuations in wind power generation which are hardly predictable in a precise way. When wind power penetration increases, especially the balancing of load and generation in real-time becomes a more difficult task for the transmission system operator.

Due to this, we explore the question whether enforced balancing within each power generating company, or initiated and coordinated between these companies, can reduce the burden on the transmission system operator. This could be highly advantageous if it would lead to efficiency gains from the system's perspective, measured as changes in welfare.

To assess the value of this "self-balancing", we model possible decisions for power generating companies in a test system under different scenarios. The strategies of those companies differ with regard to the provision of bids to the real-time balancing market and the use of rescheduling between different types of power plants within the same company.

Both the test system and the scenarios represent the most important characteristics of the Nordic power system. The scenarios contain different levels of wind power generation, and wind power forecasts of different quality. These data are taken from Nord Pool, the Nordic countries' power exchange. They are available for Denmark, a country with an

already significant wind power penetration level. To match the test-system they are scaled. For updated predictions closer to real-time persistent forecasts are applied.

The model is based on a sequence of linear optimization problems for the clearing of the different submarkets. Both the data and the model have an hourly time resolution. The need of real-time balancing by the TSO, the imbalances on the generating companies' level that are settled ex-post after the delivery, as well as the extent to which the generating companies rescheduled their production are used as indicators to evaluate self-balancing.

Besides an assessment of the value of self-balancing, the paper also explores suitable ways how it could be triggered through the electricity market design. Here, the imbalance settlement rules have shown to be of central importance.

SDWS2012.0189 Impact of World Fossil Fuels Shocks to Spanish Market and Sector Portfolios: a Multivariate Dynamic Heteroskedastic Approach

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Abstract

The variability in world oil, gas and conventional fossil fuels prices has traditionally awakened the interest on their impacts on the economy and recently in financial markets. While the governments are concerned about the effects on the macroeconomic variables, academics also try to understand about how the financial assets return and risk respond to these shocks. Although there are some studies analyzing the impact of fossil fuels shocks on stock markets, individual and institutional investors demands information about the impact of these shocks to specific sector portfolios on different markets. In response to that need, this study examines the level of volatility transmission between the world fossil fuels and the stock market of one of the leader countries in renewable energies around the world: the Spanish context. Instead of focusing on global stock indexes where some confounding effects could appear as a consequence of aggregating different industries, the analyses carried out in this paper are at a sector portfolio level. This could bring investors relevant information about how the different industries respond to the shocks considered. Additionally, the study of the Spanish case, a context with a high development of renewable energies, is relevant because the results will show how Spanish companies are exposed to the variations of traditional fossil fuels. This paper employs a multivariate BEKK GARCH approach to estimate the volatility spillovers, which is a more robust

method and will provide more accurate estimates than those identified in previous research. This paper analyses the period comprised between the years 2001 and 2010. This is of special interest because that sample covers the mid-2008 to 2010 period, when the global financial crisis led the main developed countries to enter into an economic recession appeared. The results of this paper will tell us about if fossil fuels shocks contributed or not to the downturn of the Spanish market. We show that world fossil fuels shocks have a significant contemporaneous impact on the Spanish market and on Spanish sector portfolios. However, the magnitude of these shocks along the industries present some different patterns, which are addressed by estimating several news impact surfaces. Our results provide important implications for investors and interesting insights for further research in this field.

SDWS2012.0413 Electricity Prices and Energy Dependency: a Strategic Challenge in the Spanish Case.

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Abstract

Spanish has a energy dependence of around 80%, a level much higher than European average (50%). This energy dependency can entail important effects in the Spanish electricity prices as a Marginal Price auction Systems is used to asset the final wholesale price. In daily market, electricity generation selling companies determine the offered amount and price according to their short-term marginal cost (which are the variable cost of producing one extra unit of electricity -including the fuel, the emissions, and the operation and maintenance costs). The supply curve is constructed according to the "merit order" of plants of different technologies in generation markets, ranking capacity from the cheapest to the most expensive (in terms of marginal costs). The cut point between the demand and supply curves determines the wholesale electricity price which coincides with the offered price by the generator with highest marginal costs which is necessary to coverage the demand. In Spain, the technologies mainly covering the demand are those based on gas and in demand peaks, fossil production technologies tend to be marginal plants. Our electricity prices are linked to international primary energy prices because gas and petroleum used in the electricity generation are totally imported and coal used is 70% imported. The objective of this paper is to analyze the influence of the energy dependency and primary energy imported prices on Spanish wholesale electricity prices.Moreover, environmental policies could lead to higher marginal cost. In that sense, as an European Union Emission trading system exists it is also important to analyse the impact of CO_2

prices on wholesale electricity prices.However, the sample data related to the price that the market assign to carbon emission allowance is relatively recent since prior to 2005 there is no data available on this quantity. Therefore, the empirical analysis relies on yearly data collected from 2005 to 2010. In this situation of scarce information when trying to estimate the wholesale electricity price model through regression procedures a dimensionality problem exists. As an alternative to estimate the model, we propose a Maximum Entropy Econometric approach which requires the application of the tools provided by the Information Theory. As expected, the obtained results indicate that imported primary energy prices are very important to explain Spanish electricity prices-but also emissions prices.

SDWS2012.0412 Setting the Wholesale Electricity Price in Spain. A Simultaneous Equations Model Based on Maximum-Entropy Approach

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Abstract

One of the key concepts in the Spanish electricity industry liberalization process has been the creation of a wholesale electricity spot market as a way to allocate production and determine wholesale prices. In daily market, the supply curve is constructed according to the "merit order" of plants of different electricity generation technologies, ranking capacity from the cheapest to the most expensive (in terms of marginal costs). In parallel, electricity consumers establish the demanded amount. Finally, supply and demand settle at the same marginal kWh cost of electricity.

This paper presents a simultaneous equations model to analyse simultaneously quantity and price in the wholesale electricity markets.

In general, electricity demand is mainly determined by general economic activity, population activities, energy efficiency and atmospheric conditions.

In general, electricity supply is mainly determined by generation cost. Thus it is important to take into account different electricity generation technologies in the model specification as different technologies will result in different marginal costs and then different wholesale electricity prices. Spain has high external energy dependence so generation marginal costs are also affected by international prices.

Moreover, environmental policies could lead to higher marginal cost. In that sense, as a European Union Emission trading system exist it is also important to analyse the impact of CO_2 prices on wholesale electricity prices.

However, the sample data related to the price that the market assigns to carbon emission allowance is relatively recent since prior to 2005 there is no data available on this quantity. Therefore, the empirical analysis relies on yearly data collected from 2005 to 2010. In this situation of scarce information when trying to estimate the simultaneous equations model through regression procedures a dimensionality problem exists.

As an alternative to estimate the model, we propose a Maximum Entropy Econometric approach. In this paper we consider the problem of estimation a simultaneous equations statistical model for the wholesale electricity market when information is limited.

The obtained results suggest that the import prices of primary energy sources plays an important role in determining wholesale electricity prices in Spain. Regarding the demand elasticity to price a lack of demand response is found.

SDWS2012.0211 Harnessing Variable Renewables by Installation of Pumped Hydropower Storage in Croatia

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Abstract

Croatian Power system is characterized by large production share from hydropower plants. In the period 1998-2010 they had mean monthly production of 505 GWh with the maximal production of 1056 GWh in December 2010 and minimum production of 166 GWh in September 2003. The seasonal production is evident as mean monthly production in the period November-February was 608 GWh while mean monthly production in the period June-September was 337 GWh. In average, hydropower plants covered 38% of electricity consumption on monthly base or from 14% in summer months to 70% in the winter months. The rest of demand was covered by production from thermal power plants and import as the share of wind energy and other renewables was minor.

The current Croatian energy strategy sets the goal for installation of 1200 MW of wind power plants until 2020 and currently the registry for renewable energy projects has more

than 6500 MW of applications for wind energy power plants. The limit for secure operation of Croatian power network has been set to 360 MW of installed power of wind turbines. The limit is based on the decision from Croatian Ministry of Economy, Labour and Entrepreneurship from January 2007 and has not been changed over time. The most of hydropower plants are dispatchable and they can be very well used for integration of variable sources, additionally hydropower plants could be converted to pumped or reversible hydropower plants which can store excess of variable production and use it when needed.

This paper brings analysis of use of the most widespread storage technology in power systems, the pumped or reversible hydro storage (PHS) as possible measure to increase penetration of variable renewables. The results show that there is potential to expand current hydropower plants to PHS and depending on converting technology and assumptions increase storage potential 3-10 times which could also increase current limit for wind penetration to 3-8 times higher values.

Biofuels and biorefineries I

Keynote presentation

SDWS2012.0319 Sustainable Bioethanol Production and Intensive Agricultural Practices

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Abstract

With a world's population greater than seven billion people, and increasing, sustainable intensive food and fuel production technologies must be used. The close proximity of corn, cattle, and bioethanol production within the Corn Belt of the United States gives the opportunity to produce biofuels while sustaining intensive agriculture. Material and energy balances for various options of waste and byproduct utilization of a starch feedstock ethanol plant are evaluated. The introduction of the production of cattle meat into the sustainability loop is also investigated.

Because of the concentration of bioethanol plants in the Corn Belt in the United States the potential for the production of by-products with significant animal feed values and fertilizer content is significant. Not only are the processing byproducts, such as distiller's dried grains with solubles (DDGS), important in the examination of the sustainability of bioethanol production from starch-based sources. The crop residues, such as corn stover, are also significant.

Realizing that starch is the only part of the corn utilized in the production of ethanol, sustainable utilization of the remaining components is investigated. The use of the corn and bioethanol byproducts and wastes are evaluated. The importance of cattle production as a major third process in the sustainability loop is examined.

DDGS is a rich protein feed and it has increased the availability of phosphorus compared to a normal feed mix. The growth of the bioethanol industry the Corn Belt, where there is an abundance of corn and a high concentration of livestock and poultry operations, is providing significant market growth potential for DDGS. The livestock and poultry industries have the potential to consume all the DDGS produced. DDGS is a rich protein feed and it has increased the availability of phosphorus compared to a normal feed mix, 90 percent in DDGS compared to 10-20 percent. The fertilizer value of manure produced from cattle fed a significant DDGS diet is evaluated. Of particular note is the enhanced available phosphorus values obtained in the manure.

The use of the corn stover after harvest is another important consideration for determining the sustainability of the intensive agriculture methods and bioethanol production. Critical evaluations are made regarding the use of the stover as an energy source for the ethanol plant, or as a feedstock to an adjoining cellulosic ethanol plant, or simply as an animal feed.

The practicality of a closed-loop cattle feeding, ethanol producing plant is also discussed.

SDWS2012.0082 Integration of Fischer-Tropsch Diesel Production with a Complex Oil Refinery

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Abstract

The oil refining industry is a large fossil fuel consumer. Today and in the future, harder regulations (e.g. the EU ETS system and Renewable Energy Directive) are put on both CO_2 emissions from the refinery process and on the refinery products, which will give new incentives for the oil refining industry to act towards CO_2 mitigation measures and to increase the renewable content in its products.

One of several ways to increase the renewable content in refinery products and at the same time reduce CO_2 emissions, from both the refinery and from its products, is to produce fuels from forest residues. Gasification of residues from forestry has been raised as a promising option for production of transportation fuels, i.e. Fischer-Tropsch (FT) diesel. Several studies have investigated the integration of biomass gasification in different industries (i.e. pulp and paper industry and district heating systems). However, before the FT product can be used in today's car engines it needs further processing. In these steps, using the current refineries has several advantages. The refinery structure offers a utility system already in place, process units in which the FT product can be co-processed along with crude oil as well as a long tradition and knowledge of producing transportation fuels.

In this paper, the results of a case study on biomass gasification integrated with a complex refinery (crude oil capacity of 11Mton/year) are presented and compared with a stand-alone gasification plant for FT products. Pinch analyses have earlier been performed for the studied refinery and the gasification process, respectively. This paper evaluates the integration of biomass gasification with the refinery, including upgrading of the FT

products (both using the current process units and installing new units at the refinery). A comparison with a stand-alone gasification plant with upgrading to FT fuels at the current refinery is also included. This paper presents the impact of integration between the refinery, gasification process and upgrading units on the overall heat and mass balance as well as the CO_2 emission consequences.

The results of this energy system study indicate interesting matches between the constituted parts, i.e. the refinery, the gasification, production of steam, generation of electricity and the production of transport diesel. The result shows, among other things, that an adjusted design is more adapted to the objective (i.e. gives higher yield of FT-diesel than co-processing in current units), that heat from the gasification process can be used to cover the heating demand of the refinery process and that the largest amount of electricity can be generated in a stand-alone gasification process. This study should be followed by an economic evaluation in order to identify the most optimal system solution.

SDWS2012.0150 Neural Network Modelling of Sugar Beet Juices Fermentation with Different Starter Cultures

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Abstract

Interest in the use of biofuels has strongly grown worldwide. From economic point of view and in comparison with cereals, sugar beet and intermediates from beet processing are very good raw materials for ethanol production due to their content of fermentable sugars, which can be directly used for fermentation without any modification. An increase in sugar production yield and efficiency has led to reduction in required quantities of sugar beet. Introducing the concept of sugar and ethanol coproduction is an attractive option for domestic sugar factories, as it provides flexibility in terms of variation in produced quantities of sugar and ethanol, depending on prevailing conditions on the market. Neural network applications in bioprocesses are numerous, and their implementation in biotechnology is the object of many studies. The aim of this study was to investigate possibilities of using artificial neural networks for experimental results prediction and to find its optimal topology and examine possibilities of finding influence of input variables on selected outputs. The results of bioethanol production in batch culture by different starter cultures from different intermediate products (raw, thin and

tick juices) and molasses as byproduct of sugar beet processing were used in network selection. A feed-forward back-propagation artificial neural network was used to test the hypothesis. Type of applied sugar beet juice for media preparation and fermentation time were used as input variables. The results obtained suggest that artificial neural networks are good prediction tool for selected network outputs. It was found that experimental results are in very good agreement with computed ones.

SDWS2012.0158 Biodiesel: Transesterification of Rapeseed Oil by Hydrotalcites

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Abstract

Biodiesel is an ecological fuel for combustion engines. It is produced by transesterification of triglycerides contained in vegetable oils by low molecular alcohols. The reaction is usually carried out at homogeneous catalyst, but this way has several disadvantages therefore nowadays research is turned to heterogeneous catalysts, one of them are hydrotalcites.

Hydrotalcites (HTs) represent a group of mainly synthetic layered materials known also as the anionic clays or layered double hydroxides with general formula $[M^{II}_{1-x}M^{III}_{x}(OH)_2]A_{x/n}^{n-}.zH_2O$ (where M represents metallic cations and A is anion). Hydrotalcites are often used in heterogeneous catalysis as precursors for preparation of mixed oxide catalysts. The chemical conditions of hydrotalcites could be changed by various metallic cations.

In this study, Mg-Al hydrotalcites with different Mg/Al molar ratio were prepared and moreover their properties were changed by rehydration and calcinations using different temperature. The comparison of the influence of these changes to activity of catalyst was studied for the transesterification of rapeseed oil. The catalytic activity of Mg-Al hydrotalcites was tested in three types of reactors: the batch reactor equipment with cooler and autoclave. After reaction, the catalyst was separated by filtration. Techniques such as XRD, FTIR, ICP-AAS, SEM were used for determination of structure, basic strength, active sites and surface area.

Moreover the effect of several reaction parameters was studied: reaction temperature and time, amount of catalyst and molar ratio of methanol to oil. The transesterification was monitored by determination of reaction intermediates (mono-, di- and triglycerides) and the leaching of metallic ions was determined in the liquid phase (the ester and glycerol

phase) by AAS. The leaching of ions can cause catalyst deactivation and therefore make impossible their reuse; this leaching determination is very often omitted in papers. It was determined that the leaching is less than 1%. It was found that higher molar ratio Mg/Al causes higher catalyst basicity. This information was confirmed by FTIR spectra and determination of basicity by Hammets indicators.

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SDWS2012.0207 Study of the Heat Release Rate of Hcci Fuelled with Biodiesel Combustion Using a Multizone Model Approach

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Abstract

The aim of this study was to examine the potential of a multi-zone model to simulate a homogeneous charge compression ignition (HCCI) engine fuelled with biodiesel fuel. HCCI with biodiesel fuel is being considered as an alternative combustion process in the internal combustion engine, mainly because of the huge potential for simultaneous reduction of NO_x and soot emissions while fuel conversion efficiency is not compromised. In this work a numerical study based on a multi-zone model was developed and validated with experimental results. The multi-zone model presented here is structured in zones that are located in fixed positions within the combustion chamber and where the composition and temperature are homogeneous in each zone. The zones exchange mass according to their configuration in order to maintain a uniform in-cylinder pressure and temperature are homogeneous in each zone. The start of combustion and its development were considered through specific formulations that were fitted to the model through a comparison between combustion chamber pressure measurements and model results. The model was applied to the HCCI combustion mode with late injection and with high turbulence intensity, and showed a very good capability for process simulation and also includes the kinetics of NO_x and CO formation and gave data that were close to the experimental results.

In the model a heat release rate (HRR) law that models the HCCI process was used. The global HRR is evaluated from the instantaneous energy released during combustion for

each zone. The parameters of this law were adjusted through an optimization process that allowed the combustion chamber pressure given by the model to be fitted to the experimental results.

The model predicts the performance of the HCCI engine in terms of combustion pressure, HRR and NO_x and CO emissions. There is a slight deviation of the simulated peak pressure curve versus the measured pressure curve obtained from experimental tests. This difference can be explained since the multi-zone does not account adequately for composition mixture. The developed model appears to be a useful tool for studying the HCCI combustion mode fuelled with biodiesel and provides information on the spatial distribution of temperature inside the combustion chamber.

SDWS2012.0304 Prospects for Alternative Energy Carriers Based on Biomass Sources in EU-15 Up to 2050

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Abstract

Some years ago there were huge promises from the possible contribution of biofuels to reduce the use of fossil fuels and CO_2 emissions. Recently, these expectations were cut down. Especially, bad ecological performance and the problem of competition with food production led to criticism of 1st generation biofuels. However, there is still hope regarding 2nd generation biofuels as well as hydrogen and electricity from biomass, mainly based on lignocellulosic feedstocks from non-arable land.

In this paper we conduct an analysis of the economic and the ecological aspects of alternative energy carriers based on biomass sources. These sources encompass short rotation copies, forest wood residue, wood industry residues, waste wood as well as energy crops. In 2010 the energy output from alternative energy carriers from biomass was about 800 PJ in the EU-15. We show which energy output from these energy carriers can be expected in the future till 2050 under the following conditions: with and without a CO_2-based tax; with and without additional arable land (max: 30% use of arable land). We also consider different priorities for hydrogen, biofuels or electricity generation.

The major result of this analysis is that depending on the scenarios described above energy output of considered energy carries in to 2050 could be between 2500 PJ (scenarios with no CO_2 based tax and no additional arable land) and 6000 PJ (scenarios with CO_2 tax and additional arable land use). In this case the impact of additional arable

land is about 2500 PJ. This analysis also encompasses the possible transition from 1st to 2nd generation biofuels.

The major conclusion is that even in the most promising scenario by 2050 only an additional energy quantity of about 5000 PJ from biomass can be produced which equals about 8% of the total final energy consumption in EU-15 in 2008, which was about 65000 PJ.

Energy planning II

Keynote presentation

SDWS2012.0149 EROEI Index (Energy Return on Energy Investment): a New Method to Qualify Energy Projects

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Abstract

This research stems from the need of assessing a power plant or an energy source on mere physical basis, leaving aside any other parameter which can be affected by men such as the economic, financial, and social ones. As such, we hereby explore a new approach to the analysis of profitability. This approach is based on the Energy Return on Energy Investment (EROEI) index, which is still quite neglected especially in Italy. EROI is the ratio of primary energy obtained from the considered plant or source to the primary energy needed for the use of the considered source or the construction of the considered plant. This approach is extremely innovative. Among the wide range of energy efficiency indicators which take into consideration a large spectrum of man-biased variables, the EROEI relies upon the advantage of considering energy – and therefore physical - variables. As such, this ratio turns out to be hardly influenceable by the strategy of measurement and by who uses it, being therefore able to provide a rather precise picture of the profitability of a power plant. These carachteristcs allow the EROEI to be extended to wider concepts such as the profitability of an energy source. It has to be taken into consideration that the use of this kind of analysis is still at an early stage. As such affected by several uncertainties, such as the evaluation of energy expenses and the operations which contribute to energy consumption, notably during the construction of a power Through this research, we evaluated the performance of the solar thermodynamic power plant of Priolo Gargallo during its activity, getting comfortable results. The advantages and the drawbacks of the EROEI index have been deeply explored with the aim of identifying solutions to the problems which have emerged in order to evaluate the relevant terms in the calculation of the energy expense and the provided energy. For the case study, the analysis has been based on the Montecarlo statistical method, which estimates the probability distribution of the expected value of the indicator, depending on the variation of the parameters which affect it. The aim of the research is to highlight the strengths of the EROEI index in order to understand whether the EROEI index will increase its use in the future with reference to the analysis of the power plants profitability, provided that further research will improve the method.

SDWS2012.0266 Integration of Temperature and Dust Effects in Solar Energy Resource Assessment

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Abstract

Recently, solar PV technologies witnessed a commercial vigor due to their tremendously decreasing prices. However, these technologies are vulnerable to dust and temperature which can significantly degrade their efficiency.Taking into account, the effect of dust and temperature during the site assessment for large PV power plant will reduce their vulnerability and optimize their operation efficiency. Most of the site assessment for large PV power plants does not take into consideration spatio-temporal variability of dust and temperature effects due to their measurement complexity.This paper presents an original approach of integration of the effects of temperature and dust in siting large PV power plant using Fuzzy logic and GIS-based spatial multi-criteria evaluation. Dynamical downscaling approach of the high resolution COSMO Numerical Weather Prediction Model is used to simulate the annual pattern of temperature and the Aerosol Optical Depth (AOD) derived from Multi-angle Imaging Spectro-Radiometer (MISR) is used to retrieve the contamination degree of the air with mineral aerosol.Land suitability analysis for large PV farms implementation is carried out for the case study of Oman. Compared to previous results obtained without temperature and AOD, the new results show that several areas are declassified because of their exposure to high temperature and dust risks. It is noticed that the highly suitable land areas decreased significantly by 81% after considering the temperature and dust constraint layers. Different PV technologies are considered and it is found that the Concentrated Photovoltaics (CPV) technology provides higher potential for implementing large solar plants. In fact, if all highly suitable land is exploited for CPV farms, it can supply more than 750 times the current total power supply in Oman estimated at 16.1 TWh in 2010.

SDWS2012.0458 Modelling Energy Demand to 2050 in the EU Building Stock

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Abstract

In the on-going effort within the EU to tackle greenhouse gas emissions and secure future energy supplies, the buildings sector is often referred to as offering a large potential for energy savings. The aim of this paper is to use bottom-up modelling to produce scenarios that highlight how such savings can be realized. The focus is on the potential role of improvements in energy efficiency and the impact of increasing living standards and floor areas. The aim is to provide a conceptual framework for the development of fiscal and regulatory policy decisions in relation to various categories of energy efficiency measures, with the overall objective of meeting future demand for energy services of the building sector within the EU in a sustainable manner.

The bottom-up approach used in this work models the explicit impact of trends in energy efficiency improvement on total energy demand in the EU buildings stock using three different scenarios. Rates of energy efficiency improvement used are exogenous model inputs obtained from a literature review of relevant papers. The particular categories of efficiency examined are; heating fuel conversion efficiencies, heating standards for new buildings and heating and appliance end-use efficiency. Alternative fuel mixes are also examined. The rates for expansion of floor area and increases in living standards are kept constant in all three scenarios. Results obtained are compared to those from other studies focusing on future energy demand in the EU building stock.

The work builds on that first carried out in the project "Pathways to Sustainable European Energy Systems", in which pathways for EU 27 up to the year 2050 were assessed, including the building sector (Göransson et al., 2011). Model outputs to date estimate that if energy efficiency was frozen at today's level, expansion of the building stock and other increases in standards would increase final energy demand in the EU by almost 70% by 2050 whereas continuing efforts at efficiency along current rates could stabilise energy demand. A reduction consistent with the EU's 20% efficiency improvement target for the year 2020 is also shown to be possible, but needs forceful policy for success.

Göransson, A., Ó Broin, E., Mata, E., (2011). Future end use energy demand in the European Building Stock, in Johnsson, F. (Ed.), 2011. European Energy Pathways: Pathways to Sustainable European Energy Systems. The Alliance for Global Sustainability, Mölndal. ISBN 978 91 978585 1 9.

SDWS2012.0498 Context-Based Energy and Environmental Management System: the Lifesaver Approach

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Abstract

Secure energy supply and climate change are the most serious challenges facing humanity in the 21st century. This truly global problem already initiated the fundamental transformation of fossil fuel powered industrial economies. The European Union has adopted a set of common rules on environmental permissions for industrial installations and established a European Emission Trading Scheme. The aim of emission trading is to achieve emissions reductions at the lowest economic costs.

In many industrial companies different monitoring and control systems are used, but most of them are not directly connected with the optimisation of energy use. Modern industrial processes are increasingly complex and flexible, leading to highly dynamic energy usage patterns and difficulties in identification of correlation between overall CO_2 emissions and specific processes. The greatest challenge in the optimisation of the highly dynamic industrial processes is to complement currently measured energy consumption data with diverse information from ambient intelligent systems (e.g. interactions between human operators and machines or processes) and process related measurements (e.g. temperature or oil level of a specific machine). The main objective is to enrich energy consumption data with information about the context in which the use actually occurred. The use of this additional information enables the creation of a high resolution image of the energy consumption in the different manufacturing operations. This new or unused information represents a significant potential to support decisions in the scope of maximising energy savings as well as minimising and trading with CO_2 emissions.

In this paper, leading methods and tools relating to context-aware processing of ambient intelligence data for energy saving and CO_2 emission calculation, energy models, patterns and consumption prediction, decision support for energy savings verification and emissions trading have been evaluated. Special attention is given to the identification of the main gaps in the current state-of-the-art, defining the ones that will be addressed by the LifeSaver project. LifeSaver project is funded under the Seventh Research Framework Program of the European Union and it aims at supporting manufacturing companies in optimising the energy performance of their operations.

SDWS2012.0350 Strategy of Sustainable Energy Development in EU – Monitoring and Measurement of Economic Development and Renewable Energy Production Limitations

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Abstract

Research, technological development and innovationwill remain major drivers for renewables deployment in the coming decades. Even technologies close to maturity, like wind energy will see further improvements and completely new concepts enter the markets. Aspects related to the systems technology for integration of renewables into existing energy infrastructures will receive more emphasis. The problems of the intermittent character of some renewables will be largely overcome through new storage technologies under development that can be expected to enter the market in the coming years. Distortions resulting from unequal tax burdens and existing subsidies, and the failure to internalize all costs and benefits of conventional energy production and use, erect high barriers to renewable energy. Additional barriers include the cost of the renewable energy technologies themselves (and the need to achieve economies of scale in production), the lack of access to affordable credit, the costs of connecting with the grid, and transmission charges, which often penalize intermittent energy sources. In many countries, electric utilities maintain monopoly rights to produce, transmit and distribute electricity. High costs or a lack of standards for connection and transmission discourage renewable energy projects. In addition, lack of information about available renewable energy resources and about the current state of renewable energy technologies, or negative past experiences with old technologies, and a lack of understanding about the benefits associated with renewable energy all act as barriers to their use. Each of these factors works to increase the perceived risks—technical and financial—of investing in renewable energy.

Wastewater treatment

Keynote presentation

SDWS2012.0064 Improvement of Nitrogen Removal in a Large Municipal Wastewater Plant

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Abstract

The wastewater treatment plant serving the metropolitan area of Turin is connected to the Po river near the town, in an area that has been considered very critical for potential eutrophication phenomena. This fact leads to the requirement of very high nitrogen removal performances for the plant; with this purpose an examination of water treatment line and sludge system has been performed, in order to identify potential interventions suitable to obtain the required improvement. First of all an analytical screening of the nitrogen concentrations in different points of the plant was performed in different positions: for the wastewater line before and after the biological denitro – nitro section, for the sludges at the internal recycle coming from dewatering, and also as immission point for the different external residues that are treated together with wastewater. The experimental results have been used to construct a nitrogen mass balance in the plant and to identify the removal capacities that the different treatments operating in the system are able to realize. On the basis of the performed observations, two fundamental technological solutions in order to improve the nitrogen removal have been identified. The first one, to be realized on the waste water treatment system, doesn't require plant innovations, but only interventions on the biological treatment tanks. Measure and control systems are considered, in order to improve the utilization of the tanks volumes and to optimize the shifting from aerobic to anoxic conditions, and from anoxic to aerobic. The second technological solution, necessarily connected with a plant innovation, consists in the realization of a system of autotrophic anoxic removal of nitrogen operating on the internal recycle, with the adoption of a fixed specialized biomass bioreactor operating on the recycle flux that is very rich in ammonia nitrogen, and poor in organic carbon. The two possibilities have been deeply investigated, by evaluating the literature indications and the actual realisations in full scale plants with similar problems; on these basis it was possible to define the schemes of application of the two solutions in the considered case, and to establish the performances that could be obtained from the proposed plant modifications.

SDWS2012.0113 Biosorption of Zn(Li) from Aqueous Solution on Natural and Modified Almond Shells

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Abstract

Almond shell (AS) has been utilised as an biosorbent for the removal of Zn(II) ions from aqueous solutions after treatment with citric acid. A cationic biosorbent, which bears carboxyl groups of citric acid (CA) derived from esterified almond shell, was prepared using the solid-phase esterifying technique. Zn(II) removal from aqueous solution with modified almond shell was investigated to evaluate its capacities of cation exchange. The modification reaction variables, such as reaction time (0–24 h), citric acid level (5–10 g), and temperature (110–130 °C) were studied in batch experiments. The rate of biosorption was studied under a variety of conditions, including pH (2–9), initial Zn(II) concentration (0.1–1.0 mM), temperature (25-65°C), amount of biosorbent (0.02–0.20 g) and contact time (10–240 min). Biosorption of Zn(II) is in all cases pH-dependent showing a maximum at equilibrium pH values between 7.0 and 8.0 for almond shell and citric acid modified almond shell (CA-AS). The applicability of the Langmuir, Freundlich and D–R adsorption isotherms has been tested for the quilibrium. Maximum biosorption capacities of CA-AS and untreated AS under experimental conditions were 1.242 and 13.989 mg/g for Zn(II) ions, respectively.

SDWS2012.0438 A Technical and Environmental Problems with Production of Bitumen Materials: Toxicity, Environmental Aspects and Novel Technologies of Bitumen Wastewater Treat-Ment.

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Abstract

During the production of petroleum origin bituminous materials, at the oxidation of crude oil residuum stage, a complex composition sewages in the form of strongly emulsified mixture of organic phase dispersed in aqueous phase are produced [1]. A few percent content of the organic phase is a big difficulty for effective treatment of this type of effluents with the use of conventional technologies in which a microbiological treatment with activated sludge is mostly used. A high degree of emulsification makes typical separation systems that utilize a coalescence and flotation for organic phase separation less effective. The sewages are highly toxic in relation to the sewage sludge. A volatile organic compounds containing sulfur, nitrogen and oxygen atoms present in the sewages result in high malodourness. In the case of such type of refinery wastewater a pre-treatment step is needed as well as the containment of the treatment stages to prevent the emission of odorous volatile organic compounds to the atmosphere. The paper presents a case study for bitumen oxidation process in the aspects of methodologies for detailed identification of volatile and nonvolatile compounds present in the sewages as well as methods possible to be used for wastewater treatment. In the paper a developed novel technology for pre-treatment of such sewages is also described. In presented solution a demulsification process in the first stage and chemical oxidation in the second stage has been used. High effectiveness of the presented system gives a possibility of achieving a complete separation of organic phase in a time not exceeding 5 minutes. It allows to reduce the “load” of pollutants and the malodourness of the sewages. A compounds soluble in the water phase of the sewages can be oxidized with the use of a few alternative methods. A microscopic analysis, reversed phase high performance liquid chromatography with the eluent back-flush (RP-EBF-HPLC), gas chromatography (GC) with universal and selective detection as well as Microtox tests for toxicity evaluation were used for process control and effectiveness evaluation of the developed technology.

Acknowledgements

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SDWS2012.0525 Solution Equilibria and Adsorption Tendencies of Complexed Cu Ions in Mining Environment

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Abstract

Mining companies are regulated to ensure minimizing their negative impact on the environment. Excess water in the tailing environment of process plants is frequently released to natural rivers. Thus, the effluent quality is monitored to ensure that maximum allowable limits are not exceeded. Recently, copper concentration levels in the effluent discharge flows of a copper and nickel mining company in Ontario have indicated increasing trends. The current research involves analysis of solution equilibria under relevant conditions. A chemical condition particular to the problem is use of diethylenetriamine (DETA) in the process. Equilibrium diagrams showing variation of the copper concentration levels with respect to pH in the absence and presence of this reagent were constructed along with relevant Eh-pH diagrams. The results demonstrate how formation of DETA-copper complexes can be a potential cause of this problem. Adsorption characteristics on mineral components in the tailing environment are also discussed.

SDWS2012.0513 Biosorption of Toxic Dyes Onto Grape Residue

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Abstract

Synthetic dyes are widely used in a number of industrial processes, such as textile industries, paper printing and photography [1]. Increasing environmental pollution caused by these toxic dyes due to their hazardous nature is a matter of great concern. Even small traces of the non-biodegradable and highly toxic dyes can prove harmful to the mankind and living organisms [2] Currently, several physical or chemical processes are used to treat dye laden wastewaters. However, these processes are costly and cannot effectively be used to treat the wide range of dye wastewater [3]. Adsorption process provides an attractive treatment for the removal of dyes from waste water, whereas it requires suitable adsorbent materials that can be both inexpensive and readily available in large quantities. In recent years, many studies aimed to use different potential agricultural materials in an effective and economical way by biosorption. Especially, waste materials are focused to being evaluated as biosorbents for minimizing these wastes and protecting the water sources. The purpose of this study is to evaluate a waste material of wine industry, grape residues (residue after juice is squeezed from grape), as a cost-effective biosorbent for the removal of toxic dyes from aqueous solutions. Removal of methylene blue, rhodamine-b, and methyl orange were determined as a function of pH, biosorbent dosage, initial dye concentration, contact time and temperature of solution. Experimental results showed that grape residues can be evaluate as an alternative biosorbent for elimination of toxic dyes from aqueous solutions.

SDWS2012.0516 Removal of Heavy Metal from Aqueous Solution: Utilization of Pine Needles as a Low-Cost Biosorbent

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Abstract

Water pollution is a major environmental problem faced by modern society that leads to ecological disequilibrium and health hazards. Heavy metal ions such as copper, cadmium, lead, nickel, and chromium, often found in industrial wastewater, present acute toxicity to aquatic and terrestrial life, including humans. Thus, the discharge of effluents into the environment is a chief concern [1]. Conventional methods for the removal of metal ions from aqueous solutions include chemical precipitation, ion exchangers, chemical oxidation/reduction, reverse osmosis, electro dialysis, ultra filtration etc. However these conventional techniques have their own inherent limitations such as less efficiency, sensitive operating conditions, and production of secondary sludge and further the disposal is a costly affair [2]. Adsorption is a popular method for the removal of heavy metals from aqueous solutions due to ease in application. When choosing an appropriate adsorbent in adsorption process, parameters taken into consideration are mainly the sorption capability, regeneration ability, kinetic parameters, price and market availability [3]. By using cheap and largely available biomaterials, it is possible to reduce operating costs of adsorption process and compete with the convenient commercialized adsorbents such as activated carbon. The present study deals with the utilization of forestry waste materials as biosorbents for removal of hazardous heavy metal ions from aqueous solutions. Pine needles were evaluated as low-cost adsorbent precursor for removal of heavy metal ions. Optimum biosorption conditions were determined as a function of pH, biosorbent dosage, initial metal ion concentration, contact time and temperature of solution for Co(II), Mn(II) and Cu(II) removal. Experimental results showed that pine needle seems to be an effective, low cost, and environmentally friendly biosorbent for elimination of low-concentrated heavy metal ions from aqueous solutions.

Research

Keynote presentation

SDWS2012.0400 Pure Hydrogen/Oxygen Fuel Cell Performance Assessment for Closed-Loop Renewable Energy Systems

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Abstract

Fuel cells and electrolysis are promising candidates for future energy production from renewable energy sources. Usually today's fuel cell systems run on hydrogen and air, while electrolysis systems vent out oxygen as a by-product. Replacing air with pure oxygen, fuel cell electrochemical performance, durability and system efficiency can be significantly increased, with a further overall system simplification and increased reliability.

This work, which represent the initial step for pure H2/O2 fuel cell operation in closed-loop systems, focuses on performance validation of the MEA which showed the optimum under pure H2/O2 operation starting from a preliminary experimental characterisation of three commercial MEAs (IRD XL PFSA reinforced membrane, Baltic with Nafion 212 membrane and a Alfa-Aesar PFSA), tested using pure hydrogen and oxygen under different RH (dry-25-50-75-100%) and pressure (1-3-5 absolute bar) conditions. Critical aspects, such as membrane failure, limit operative conditions and system design have been discussed along with experimental analysis.

The results showed that:

- The best performance have been obtained from Alfa-Aesar MEA at higher RH, meanwhile operation/testing below 25% RH always led to membrane failure.

- Higher pressure increase performance in all RH conditions, but its influence is more evident at low RH.

- Despite the higher performance, high pressure and temperature combined effects often lead to membrane failure which make this operation mode very critical.

The most reliable operative conditions have been obtained at 3 bar (abs.) and high RH value (>50%), resulting in stable and reliable operation for all the tested MEAs, while low RH operation leads easily to membrane failures. Under these conditions IRD reinforced

membrane MEA has shown a high reliability in all conditions, although featuring lower performances mainly due to high membrane Ohmic resistance. caused by the presence of the reinforcement. Beside, the experimental activity has shown the critical aspects to be considered for closed-loop fuel cell systems operating with pure hydrogen and oxygen.

SDWS2012.0129 Spectroscopic Investigation of NO and CO-Adsorbed CO, NO on Rh(100)

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Abstract

Automobiles contribute considerably to air pollution, due to the detrimental emissions from the combustion in the engine. These harmful pollutants, like CO and NO, are treated in a catalytic device, which is placed under the car. They are toxic and contribute to the acidification of the environment and local smog formation as well. Therefore conversion of hydrocarbons CO, NOx, to nontoxic gases represents an important issue. The primary goal of this research is the study of the interaction of CO, NO as function of coverage at adsorption temperature 150 K, with a Rh(100) surface by means of high resolution electron energy spectroscopy (HREELS). The use of the single crystal surfaces is advantageous as they are well defined in terms of structure and composition. The (100) surface has our preference because it is intermediate in packing density between the closed-packed (111) and the more open (110). HREELS and infrared (IR) are the most commonly used vibrational spectroscopies to study the adsorption of molecules on a surface. With respect to information content, HREELS is much like IR. However, whereas IR is based on the absorption of photons, HREELS employs electrons. We are interested in the study of CO and NO as single adsorbates and mixed phases on Rh(100) by using HREELS. The practical importance of this study is that CO and NO are the major pollutants from the automobiles as noted. The internal C-O, N-O frequency indicates how CO, NO binds to the surface and it reveals the preferential adsorption site at all coverages. Additionally the CO-, NO-metal frequencies which are not detectable in IR spectroscopy but visible in HREELS exhibit information about the adsorption sites of adsorbed species in association with the internal frequency. Coadsorption of NO with CO indicates that CO internal frequency experiences a shift up in the presence of NO on Rh(100) in comparison with the CO stretch frequency of single adsorption on Rh(100). The information obtained can be used to understand how the coadsorbed species influence each other in terms of vibrational frequencies at low adsorption temperature.

SDWS2012.0225 Hydrogenation of Acrolein on Silver Surfaces-A Theoretical Approach

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Abstract

Catalytic reactions carry out best if the interaction between the adsorbates and the surface is not too strong and not too weak. According to the Sabatier's principle there is an optimum of the rate of the catalytic reaction as a function of the heat of the adsorption. If the adsorption is too weak the catalyst will not be able to dissociate a bond. If the adsorption is too strong the adsorbates will not be able to desorb the surface. Both cases result in small rates of reactions. This relates to the d-band occupancy of the metals as follows: metals to the left of the periodic table dissociate a chemical bond but the formed atoms will be strongly bound to the surface and therefore less active. The metals to the right are unable to dissociate a chemical bond. This leads for an optimum for metals in the middle of the periodical table. In this context hydrogenation of acrolein on silver surfaces raises up the question whether hydrogen (H_2) proceeds in the mechanism of the reaction as molecule or dissociates on silver catalyst and enters the reaction as atom. According to the Sabatier's principle, silver having an electronic configuration $4d^9 5s^2$ cannot dissociate the strong bond of hydrogen molecule. However it is known that even on gold provided the gold particles are very small hydrogen can dissociatively chemisorbed. To elucidate the mechanism of the abovementioned reaction we considered small clusters of silver atoms (mimicking step surfaces) by checking first their stability by means of theoretical calculations and adsorbing afterwards hydrogen in order to estimate whether the adsorption energy is exothermic or not.

SDWS2012.0584 Water Quality Evaluation of Vain Lagoon

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Abstract

Vain Lagoon is situated on the northern Albanian coast (Adriatic Sea) and belongs to Lezha district. The Vain Lagoon together with Kune Lagoon are created by the accumulated sediments from the Drini and Mati rivers. The differentiate deposits of alluvium and their connections with the sandy massive seashore have created a labyrinth of forms like arrows, arcs and sandy paths. Through channels lagoon water are connected with the sea.

Aquatic macrophytes vegetation in the Vain Lagoon is important for the activity and the existence of this lagoon. Eelgrass beds filter excess nutrients out of the water and help prevent shoreline flooding and erosion by stabilizing sediment and buffering wave action. Because it requires specific amounts of light and clean water, the presence of eelgrass is an indicator of healthy water quality**.** Eelgrasses occur in protected bays and lagoons and also in deeper waters along the coast. The depth at which Eelgrasses occur is limited by water clarity because most species require high levels of light.

The vegetation, which is mainly dominated by Zostera noltii, Ruppia cirhosa and green algae (Enteromorpha and Cladophora) is relatively poor. Some of the reasons for the small number of macrophytes types are uniformity of biotopes, high sediment dynamics, and high water turbidity caused by them, which reduces the intensity of photosynthesis.

The quality of water in Vain Lagoon is evaluated based on parameters as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Dissolved Oxygen after 5 days DO_5, pH and temperature. This study was carried out during two consecutive years (2010 and 2011). The plants and marine animals have sufficiently oxygen when DO in water is above 5 mg/l.

For the Vain Lagoon is very important its communication with the sea and the communication channels of fresh water for maintaining normal levels of salinity. Often has a high organic pollution due to the presence of people and cattle. The samples are collected in four different stations in Vain Lagoon.

DO measurement at Station 3 during March represented the lowest value (3,967 mg / l) and the highest value was recorded in April at station 4 (9,109 mg / l). The BOD value is indicator of the quality of oxygen used by microorganisms in aerobic oxidation of organic

matter. In Vain Lagoon BOD values during 2010 were ranged from 0.73 mg/l (station 1) to 4.371 mg/l (station 3). Water extreme temperatures during 2010 – 2011 were higher or lower than the respective temperature recording some year before.

From two year measurements we evaluate that water lagoon are more polluted compare of previews years.

SDWS2012.0421 Technological Progress Towards a Hydrogen Economy: an International Patent Analysis

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Abstract

Hydrogen is an energy carrier that has experienced alternating periods of highs and lows within the global energy governance agenda. Relevant pros and cons have been widely discussed but uncertainties still remain over the role that hydrogen can play in moving towards a clean and sustainable energy future. Among all, the need for displacing emissions from urban to rural areas and technical obstacles posed by its low energy density have continuously alternate in encouraging and dissuading further investments in research and development.

This paper analyses the trends of the hydrogen economy option by performing a patent analysis of key technologies and processes throughout an H2-supply chain.

First, an investigation of key opinion leaders involved in "Filiera H2" project is conduced to derive a taxonomy for and categorization of patents related to hydrogen technologies and processes. To this end, the "Filiera H2" project, founded by the Tuscany Regional Administration, provides the research with a well established network of scientists and entrepreneurs committed to bridging the high geographic concentration of H2-firms to a strategic and sustainable H2-supply chain.

Second, a quantitative assessment of patenting activity in Europe, USA and Japan is undertaken with reference to selected technologies and processes. Data from patent analysis tools are validated and interpreted by experts to provide reliable explanations to observed trends.

This paper presents some evidences that there is not a clear decline of the hydrogen economy. Sectoral innovation performance benefit from both a base-load of fundamental

research and applied research in green niches. Beside that, discussion of overall trends suggest that hydrogen economy is still far from the mass market.

Despite the need for more insight into alternative H2-supply chains, some generalizations of the findings of this research have important implications for policy makers, managers and researchers.

SDWS2012.0583 The Turkish Strategy for the Governance of R&D and Innovation Towards Sustainable Energy

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Abstract

R&D and innovation activities are a key asset in the pursuit of sustainable development that requires the decoupling of economic growth from environmental pressures. This has led to the revival of the need for mission-oriented programs, which were once prominent for the area of aerospace, in new areas, including energy and environmental technologies. The focus for the governance of innovation systems has also started to shift from purely economic aims, e.g. increasing gross domestic product, towards a plurifocal viewpoint that couples these aims with the goal of sustainable development, while "motors of change" are sought to accelerate system functions.

This paper analyzes the strategy of Turkey in the process of activating the national R&D and innovation actors in the area of energy technologies to "utilize energy resources effectively and efficiently without compromising environmental quality and welfare." This process was initiated in 2010 by decree of the Supreme Council for Science and Technology (SCST) to prepare the National Energy R&D and Innovation Strategy. The milestones of this process included horizon-scanning reports, workshops, and working group meetings that involved a broad range of stakeholders in the field of energy. The National Science, Technology and Innovation Strategy 2011-2016 also identified "energy" as one of the areas in need of a mission-oriented approach to boost R&D and innovation.

After a preparatory process that lasted more than a year and coordinated by the Scientific and Technological Research Council of Turkey (TÜBİTAK), SCST approved the Strategy in the end of 2011. In addition to mission-oriented R&D projects, capacity advancement, commercialization and cooperation in the field of energy, this strategy includes an all-encompassing "governance" dimension. Accordingly, in spring 2012, a High-Level Prioritization Meeting was held to prioritize the technologies in the energy field and

consultation councils have prepared the first energy calls in the sub-topics of energy storage, solar energy, and clean coal technologies. Call-based projects are set to be financed by the new, grant programs of TÜBİTAK in prioritized areas, including energy.

The latest energy statistics indicates that the primary energy supply of Turkey is 109.3 million tons of oil equivalent (Mtoe). The final energy consumption of 83.4 Mtoe is shared among the industry (37%), building (34%), transport (19%) and other (10%) sectors. It is envisioned that the process as analyzed in this paper will put into place a R&D and innovation based “motor” in the energy field. Ultimately, it is evaluated that this motor has the potential to serve some of the main targets of Turkish energy policy to decrease the energy intensity of the economy by at least 20% and increase the share of renewable energy in electricity generation to 30% by the year 2023.

Energy policy I

Keynote presentation

SDWS2012.0485 Economic Benefits of Combined Technologies: Electric Vehicles and PV Solar Power

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Abstract

Economic benefits of combined technologies: Electric vehicles and PV solar power

To counter global warming, people seek to combine renewable technologies to obtain an integrated unit of technologies that is environmentally friendly. Although this combination can be more beneficial from an environmental viewpoint, it is not clear whether from an economic angle it is also the most profitable option for investment. The paper focuses on the following research question: When one has an initial investment capital of I_0 euro to invest in N several clean technologies, would it be most profitable to invest the entire amount in one separate technology or to invest the total I_0 euro in the combination of all N separate technologies?

This paper develops an economic assessment model of integrated technologies. The model is based on the newly introduced concept of "benefits of combined technologies" (BOCT), which is defined analogously to the existing concept of economies of scope (EOS). Where EOS are used to analyze the costs of companies producing multiple outputs, BOCT focuses on the costs and benefits of technologies producing multiple outputs. Moreover, BOCT are said to exist if the $NPV_{A,B,...,N}$ of the integrated technology exceeds the maximum of the NPV_A, NPV_B, …, NPV_N of the separate technologies.

The model is illustrated using a comprehensive case study of electric vehicles combined with a photovoltaic power source. By means of extended cost benefit analyses, the authors demonstrate that BOCT occur at several combinations of fuel prices, green current certificates (GCCs), and electricity prices. As a final step, the paper determines which of the parameters are most important in determining the presence of the combined technology benefits. It is found that the unit cost of PV is crucial in determining the presence of BOCT, followed by the tax benefit on electricity. The other nonlinear variables are all negligible in this example.

Firstly, the calculation of BOCT can be useful –purely economic- for investors. Moreover, any investor should verify whether it is most profitable to invest in one single

technology or in an integrated unit of technologies, depending on the external assumptions. Further, the concept of BOCT can be particularly useful as guidance for the development of governmental policy measures aiming to reduce greenhouse gas emissions. By focusing on the benefits of combined technologies (and by broadening the range of combined technology benefits, or by increasing the amount of BOCT given a particular combination of assumptions), a proper mix of clean technologies can be stimulated.

SDWS2012.0172 The Value of Supply Security: the Costs of Power Outages To Austrian Households, Firms and the Public Sector

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Abstract

This paper presents a model for assessing economic losses caused by electricity cuts as an approximation of the value of supply security and develops a model to estimate the economic costs of simulated blackouts in Austria.

Although the supply of electricity is relatively reliable in Europe, maintaining this degree of reliability in future involves a number of challenges. Efficient decisions on investing in infrastructure are possible only if the value of the good "supply security" is determined. To obtain an objective result, the authors carried out polls covering economic costs and personal feelings in the case of a blackout, and derived the macroeconomic effects from the economic costs incurred. The polls were carried out with households, the public sector and firms. This paper uses a comprehensive approach to calculate the monetary value of a reliable supply of electricity for the whole of Austria, with a fairly fine-mesh classification of economic sectors. As a result, not just particularly vulnerable sectors (such as the semiconductor industry, papermaking or data-generating processes), but all sections of the economy as per OENACE 2008 are modelled. The wide range of possible blackout scenarios, lasting from one to 48 hours, covers many different conceivable outages for all the provinces of Austria; it is thus possible for the first time to judge subsectors of the Austrian economy province by province as regards their degree of dependence on a reliable supply of electricity. This paper does not cover blackouts lasting longer than 48 hours, with their hard-to-assess social impacts, and outages in the second

to minute range, which the authors regard as all but impossible to represent objectively in economic terms.

The economic losses are calculated for simulated power cuts with a duration from 1 to 48 hours, taking the respective day of the week and time of day into consideration. The simulated power cuts can be defined for the 9 Austrian provinces and the costs due to power cuts are computed separately for all sectors of the economy and for households. For instance, the average Value Of Lost Load for a power cut lasting one hour on a workday morning in summer was calculated to be € 17.1.

There is a need for more research into monetarizing "supply security", particularly at the transnational level. Given that European markets for electricity are increasingly interlinked, and that interdependence across borders is more and more marked, there seems to be a very strong case for assessing "supply security" uniformly throughout Europe.

SDWS2012.0200 Policies for Wind Power in Brazil

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Abstract

This article reviews the regulatory framework supporting wind power development in Brazil. Wind power is growing rapidly. By the end of 2011, it corresponded to 1,14% share of the Brazilian power mix, and annual growth rates exceed 50%. Projects contracted over competitive auctions in the past three years must enter operation until 2014, when the share of wind power in the Brazilian power mix will rise to near 6%, and installed capacity should increase in 450% in three years.

Brazil was the pioneer country in Latin America to promote wind power, through the implementation of the PROINFA, a program to incentivize alternative sources of electric energy, in 2004. The program brought long-term power agreements, insured access to the grid, feed-in tariffs, and access to special financial conditions, providing an environment with lower risks for investors. PROINFA, with its structured model of loans and regional policies, allowed the development of a local industry and the rise of competitive prices. The program was the main driver to the outgrowth of an environment in which non conventional renewable energy sources can achieve competitive prices in auctions. The migration to a higher risk environment, and the successful results in capacity contracted and price achieved, has shown a high maturity for this source. The first exclusive wind

power auction, which took place in December 2009, showed the growth potential of this source. Two years later, we look at significantly lower prices for energy, and have signals of continuing annual commercialization of an expressive amount of wind power capacity.

Brazil is considered to be one of the most promising markets for wind energy in the world. The national territory is being filled with multinationals' manufacture plants, and we are looking at a rapid growth of a structured supply chain. However, the maintenance of the industry growth depends on continuous incentives and an ensured demand. The technological development, together with knowledge and capacity building, can put Brazil in the list of major players in wind power industry. Nevertheless, the country has to consolidate its industry and market in the next few years, in order to survive to probable return of the appealing European and North American wind markets.

SDWS2012.0483 Strategies for Reducing Energy Consumption in a Student Cafeteria in a Hot-Humid Climate: a Case Study

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Abstract

Increasing attention has been given to energy consumption and potential energy savings in public buildings in order to improve energy performance. Public buildings especially cafeteria facilities due to their size and functional requirements, tend to consume a significant amount of energy. Furthermore, due to their operational characteristics and construction pattern, unnecessary energy is likely to be used for maintaining acceptable indoor environmental quality. In this study, a student cafeteria at King Fahd University of Petroleum and Minerals, Saudi Arabia, was selected for the study of energy performance and potential energy conservation opportunities. Energy simulation software Visual DOE 4.1 was used to develop an energy performance model for assessing various energy conservation measures pertinent to the building envelope and Heating, Ventilating and Air Conditioning (HVAC) system design. Data required for setting up the model was gathered through simple energy audits. The architectural and mechanical drawings and the history of electrical consumption were collected. Various energy conservation strategies were then implemented including standards, single and combined energy conservation measures. These measures resulted in a combined design saving of 27.4%, the HVAC system saving 10.6%, implementation of standards saving about 16.7%, lighting 6.6%,

equipment 2.6%, insulation 2.5% and glazing 1.4%. Based on these results, it is apparent that there is a significant potential for improving energy performance and justification to employ the suggested measures for achieving substantial energy savings and minimize energy consumption.

SDWS2012.0533 Carbon Tax and Wind Energy in Australia

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Abstract

Energy is most significant in today's life style and economic growth. Hence it is important to meet the required demands for the standard of living set by this generation. Renewable energy is known for its clean and green power generation, major research and development has been carried out in order to utilize the natural resources.

Wind energy is increasingly been used for power generation due to carbon emissions in recent years, which has also urged for changes in energy policy around the world. Many organizations around the world have developed commercial wind power farms. Wind farms are expected to be important source for power generation in many countries. The cost of energy generated by wind is competitive with conventional power plants at many sites around the world. Wind power plants are extensively used in developed countries like America, Spain, Germany, Denmark and India. Wind farms basically are the clusters of wind turbines spread over an area to generate electricity, consisting of about dozens of turbines. Choosing right location for installation plays a significant role in construction of the wind farms. Determining wind speed and direction is also important, as a rule wind speed increases over height.

Australia has excellent wind resources by world standards. Average wind speed in Australia is about 8 or 9 m/sec at 50m above the ground level. Australia is generating less than 7% of its electricity using renewable energy sources. With a change in federal government, Australia follows Kyoto Protocol (Government is planning to generate 20% of the nation's demand by 2020 using wind energy) introducing number of policies designed to combat environmental changes which has led to carbon tax issue. Australia is trying to establish renewable energy sector to combat global climate changes and greenhouse emissions. The government has proposed carbon pollution reduction scheme, renewable energy target and carbon tax on excessive use of fossil fuels as a means of reducing carbon gas emissions and to increase the deployment of renewable energy technologies for a clean and green environment. Australia has many wind farms in the Megawatt range.

SDWS2012.0210 Towards a Low Carbon Society in Croatia

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Abstract

In the last decade Croatian parliament has adopted two strategies for development of energy systems. Both strategies envisaged a large increase of energy consumption while the use of renewable energy sources (RES) varied from scenario to scenario. Even with reasonably high use of RES in the sustainable scenarios, estimated GHG emissions will surpass limits set by the Kyoto protocol or new targets for 2020 adopted trough acceptance of the EU legislation. Croatian entry to the EU is set for July 2013 so it is expected that new energy policy and planned actions will stream to the common EU goals of building secure, competitive, efficient and environmentally friendly energy system.

The paper presents the most interesting parts of a blueprint of roadmap for development of Croatian energy sector including set of new energy policy measures that could lead to building of low carbon society in 2030.

In the first part of paper historical data on energy consumption and supply are presented together with the potential for RES utilization. Used models for energy analysis and planning and results of modelling are given in the second part. Discussion and conclusion on energy policy and economic measures for promotion of energy efficiency and RES are given in the final part of the paper.

Regional planning and cooperation

SDWS2012.0215 Regional Approach for a 100% Renewable Energy Systems: the Case of South East Europe

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Abstract

Differences in countries' resources for electricity generation and good electricity grid interconnections play key role for the integration of the electricity markets in one energy community. These communities are of paramount importance for a 100% renewable energy systems in the EU as well as in the South East Europe (SEE). In order to investigate how SEE energy system may be designed to achieve high penetration of the intermittent renewable energy sources, the EnergyPLAN model was used. The reference model of SEE energy system was developed for the year 2008, which was then used for the analysis in the year 2030 and year 2050. The future energy demands were calculated with model based on bottom-up methodology which quantifies mechanisms that would lead to changes in energy consumption. Analysis in the year 2030 was made for 50% renewable energy system, which represent first important step toward 100% renewable energy system in the year 2050. Results show that 100% renewable energy system can be achieved but to achieve this goal optimal energy resource mixes; energy savings and different storage technologies are needed.

SDWS2012.0140 Integration of a Large-Scale Company Within its Regional Supply Chain Network

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Abstract

The aim of this contribution is to present the integration of a large-scale company's supplychain within its surrounding regional supply networks, based on a Mixed-Integer Programming (MIP) approach. A company's activities from the use of natural resources to supplying its final products to its customer, are thus interlinked within its regional network, typically comprising agricultural (L1), collection and pre-processing (L2), core processing (L3), useage (L4) layers, and the transportation between these layers. A model for the synthesis of regional networks for the supply of energy and bioproducts, introduced by Čuček et al., 2010 and Lam et al., 2011, was applied and extended in order to integrate a company's supplychain within the network. The objective of the synthesis was to determine economically-efficient and environmentally-benign solutions with optimal locations of raw materials, collection centres, processing facilities and consumers, optimally selected technologies and raw materials, and intermediate and final product flows.

This synthesis was applied to the integration of an existing large-scale meat company within its regional supply network. L1 includes the cultivation of food and energy crops, such as rapeseed, corn silage, barley, wheat, etc. L2 contains the harvesting of crops and the production of fodder and eggs, L3 stands for the pre-processing, e.g. slaughtering, meat-processing rendering and anaerobic digestion. As a result of optimally integrating the whole industrial enterprise supply-chain within its regional network, it is possible to identify those network reconstruction alternatives that would increase the competitiveness of the company, and the economic prosperity of the region.

SDWS2012.0305 Interregional Cooperation and Perspectives of Energy Efficiency Incentives in the Primorska Region

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Abstract

Barriers to exploit the full potential of the energy efficiency measures in the Mediterranean region are universal and not much different than in other, non-Mediterranean EU countries. Almost all Mediterranean countries have defined long-term objectives in their energy strategies but lack of clear definition of responsibilities with deadlines for the implementation was the crucial reason why many goals have not been achieved. Current situation among many Mediterranean countries is characterized by the fact that the more people is working on planning than on actual implementation of energy efficiency measures. Due to high up-front costs, energy efficiency is perceived as high cost despite its cost effectiveness in the life cycle. As the respond on above mentioned challenges 22 partners from 9 Mediterranean countries are working together within the EU funded project called MARIE (Mediterranean Building Rethinking for Energy Efficiency Improvement). The aim of project MARIE is to establish the technical, economic and social fundamentals for energy efficiency improvement in the Mediterranean Buildings Stock in the framework of the EU policies, programs and standards. Vital part of the project MARIE are pilot activities, which are foreseen in order to test and develop solutions in response to above mentioned challenges. Public buildings are recognised as the most suitable object for the demonstration of the best practices and knowledge dissemination among citizens for applying energy efficiency principles in their homes. One of the Slovenian partners on the project is Goriska Local Energy Agency. Expected positive impact of the project MARIE pilot activities on the energy consumption reduction and public buildings reconstruction process in the Slovenian Primorska region is discussed in the paper. The current situation in the Primorska region is characterised with the lack of suitable financial mechanisms for the energy efficient refurbishment of buildings within the public sector. Also, planned informational, educational and training activities within the public sector in the Primorska region are presented.

SDWS2012.0395 Heritage of the Past vs. Guarantee for the Future: Planning Local Sustainable Development on the Western Balkan

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Abstract

Main purpose of the paper is to research local sustainable development strategic planning processes and practices in theDrinaRiver Basin(geographical area delineated by the Drina River and shared among Bosnia and Herzegovina, Montenegro and Serbia). The findings should help better understanding of interactions between local government institutions and civil society in Drina River Basin municipalities in the achievement of local sustainable development, as well as the conditions enabling improved communication networks and capacity building.

Research methodology included the analysis of existing country-based strategic documents and processes, as well as local strategic documents and processes of implementation in 21 municipalities in Drina River Basin. Desk research was followed with interviews with representatives of central and local governments and civil sector during the visits of municipalities in August and September 2009 and September 2011. In addition, questionnaire-based assessment of situation and needs in municipalities were performed during 2011.

The paper argues that local sustainable development planning, although still lacking the proper methodological approach in the region, becomes more appreciated by local authorities in Drina River Basin. It is strengthened by good practices in the planning processes, particularly in Serbia and Montenegro. National sustainable development frameworks and initiatives made this approach more supportive, including donor projects in all tree countries. Moreover, local development planning in Montenegro becomes mandatory for municipalities. On the other hand, methodological framework for local sustainable development planning is still fragmented and donor driven, often poorly coordinated among donor organizations. Implementation remains a weak point. Clear and functional action plans for the implementation, including indicators of success and monitoring schemes is lacking in most strategies. The common case was the orientation on external (i.e., state and donor) funds for the implementation. Links between strategy and the municipal budgeting process tend to be weak. Majority of development strategies were sporadic or never implemented due the lack of direct link with the budget processes, or even have not been budgeted by itself. Reporting is lacking as well. Institutional capabilities for the implementation of local strategies varied, mostly following the size and development level of the municipality. Smaller municipalities with poor institutional

capacity faced the problems in the implementation, mostly in terms of weak technical capacities for project preparation and overall management of the implementation.

SDWS2012.0121 Bibliometric Analysis on International Collaboration in Clean Energy

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Abstract

Climate change is a common global issue. The development and extensive use of efficient and inexpensive renewable energy is a key to solve the issue. Advanced technology and the market for the products of current technologies to tackle the problem are spread throughout the world. Modern technology is increasingly complex and demands an ever-widening range of knowledge and skills. Often, no single country will possess all the knowledge and skills required. Technology collaboration between leading countries is important to promptly and efficiently address the problem. Previous studies have shown that a high level of collaboration is correlated with high paper productivity. In recent years, there has been a significant improvement in knowledge and skills of non hydro renewable energy research in Asian countries, as well as the US, the EU, and Japan. Therefore, comprehensive understanding on this rapidly changing structure of global academic research and collaboration is essential for government to design effective science policy in clean technologies. However, not many previous studies have been conducted on changes in geopolitical structures of clean energy research by using objective data. In particular, there are few empirical studies that focus on dynamic changes in Asia and describe the structure of international collaboration.

This paper will first aim to use objective data and create maps that enable us to see both the distribution of worldwide research competency and the relationship of international collaboration in clean energy research. Maps will be a knowledge base to help design a policy for international research collaboration. Second, this paper attempts to compare both structures. Then this paper discusses various factors that would have impacts on research capability and support strong international relationships. A bibliometric approach is used in this paper. This method is often used for the analysis of rapidly changing energy technologies.

This study outlines the development of maps, which consists of the global distribution of research capabilities and collaborative relationships, on the basis of the objective data extracted from 42,600 papers for renewable energies having high growth potential, such as wind power and solar energy. In the international research network of wind power and

solar cell, 4,189 institutions located in 121 countries and 6,600 institutions located in 125 countries are included, respectively. In terms of research capabilities, the factors related to governmental policies, natural conditions, and historical and institutional differences have been extracted. Factors concerning research collaborations, such as geographical proximity, international science and technology policy, and developmental stage of technology have been brought to attention.

SDWS2012.0078 Eco-Innovation for Promoting Green Economy: Innovation Policies in the Transport Sector

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Abstract

It was evident decades ago that many of the current environmental problems are due to the fact that resources are scarce and it would be erroneous to think that sustainability is a "social" problem that does not concern the economy. In this sense it is necessary to advocate the defence of economic growth that is ecologically compatible and based on productive transformations that limit the expansion of the economic subsystem without undermining the integrity of the environment that sustains it. To decouple economic growth from environmental degradation it is a priority and in this scenario eco-innovation is the "key" factor for it.

Given the general question, a methodology capable of integrating three dimension of eco-innovation in different sectors has been developed and the empirical approach to the problem for the transport sector is offered in this paper. In order to give a tridimensional vision of the measurement, key indicators have been selected for each one of the three factors:

- GREEN EMPLOYMENT (key indicator for social factor);
- CO_2 EMISSIONS SAVINGS(key indicator for environmental factor);
- INVESTMENT in Technology(key indicator for economical factor);

The measurement integrates the three factors using the selected indicators has been evolved into three axes (the emission savings and the employment axes share the investment axis) using an empirical approach based in the general theory.

The paper offers an innovative methodology for prioritizing different investments in designing incremental or disruptive innovation for sustainable transport that best respond to social, environmental and economic improvement simultaneously to maximise efforts in sustainability at both public and private level.

Sustainable development

Keynote presentation

SDWS2012.0050 Urban Renewal in Coimbatore City: Whither Sustainability?

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Abstract

Almost all cities in India are congested, polluted and lack in access to basic urban services essential for a healthy society. India's population grew five-fold in the past 100 years – worst affecting her cities. During the IT boom, many small towns changed into major urban locations. It would be no surprise if the Census-2011 reveals that nearly 36% of India's population lives in cities. For many years, policymakers viewed India as an agricultural economy and symptomatically treated the problems of urban areas as welfare issues. A National Urban Renewal Mission (NURM) to reverse the abject status of her cities was launched in 2005. Some of its objectives are: (1) Attention to development of urban infrastructure services while ensuring funds to meet deficiencies; (2) Planned development of the identified cities leading to dispersed urbanization; and (3) Provision of basic services such as affordable housing, water supply and sanitation to the urban poor. By the end of the mission's duration in 2012, modern and transparent management systems for all urban services are expected.

This paper provides a perspective on the NURM and its progress in one fast-growing city having several industries, academic institutions, private hospitals, and a municipal council: Coimbatore, in Tamil Nadu State. Information from websites of the mission's agencies and reports available in the public domain are used, in the backdrop of prevailing policies, to assess whether the NURM has benefited this city. Environmental problems that plague the city are reported. The City Development Plan seems unsustainable. Many NURM projects initiated to revamp the city infrastructure have missed their goals by wide margins. There is much to yearn for, in terms of a better city environment, as long as: (1) Glaring inequities in potable water supply exist alongside huge wastages forcing residents to store water for days together; (2) All kinds of rubbish is dumped in open drains and the city is content if they are removed to landfills; (3) Roads become parking lots with no provision for pedestrian movement; (4) Bad town planning causes roads to flood during heavy downpours; and (5) The city public transport system operates under non-optimum conditions. Strong-willed, mature policies to address the problems unique to this city, with public cooperation for deterrents such as a ban on plastic bags, punishments for discarding wastes in the open, provision of parking meters, etc. are needed. Without coordinated policy implementation, the NURM may well be a wasted exercise in the long

run. To avoid this, the socio-cultural and political conditions in this part of the country must be considered. The people must experience the benefits of sustainable city development in a phased manner. Urban renewal must be for its people and should not be handled as just another long-term economic investment plan.

SDWS2012.0576 Human Resources, Innovation and Sustainable Development

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Abstract

We present a study of complex relations between sustainability, innovation and employment. While on one hand sustainable development is a driver for innovation and employment, on the other hand human resource management has a strong potential for contribution to sustainable development. This is particularly important in view of the current global crisis, which is not only economic, financial, and environmental, but also a crisis of solutions. Old solutions implemented by the policy makers such as austerity measures and raising taxes have serious side effects, so new solutions are needed.

In this study we focused on the role of innovation. At the macrolevel we compared different indicators of sustainability including the environmental sustainability index, environmental performance index and their components with different indicators of science, technology and innovation as well as employment represented by the civil participation rate. In addition to the study of correlations between these parameters we also developed a feedback model, which takes into account the intertwinning effects between all three areas. Application of this model on a sample innovative organisation is also discussed. In particular, guidelines are given for optimisation of innovative aspects in human resource management toward other observed parameters in sustainability. These innovative aspects merge the best solutions from sustainability science with modern human resource management concepts in such a way, that the focus is on creating more value with less resources in a way that is enjoyable to all persons involved.

We found that all the observed areas are strongly dependent on each other, and that the proposed innovative approach to human resource management has a strong potential for contribution to sustainability, while at the same time leads to creation of new employment opportunities. It can therefore serve as an alternative approach, which can contribute to overcoming the current crises in a more sustainable way.

SDWS2012.0453 Phytoremediatory Effect of Ocimum Basilicum L. and its Rhizosphere Exposed to Different Concentrations of the Organochlorine Pesticide Endosulfan.

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Abstract

Endosulfan is an environmentally-persistent toxic organochlorine pesticide, banned and restricted in many countries. However, it is the most sold organochlorine pesticide in Nayarit state, Mexico. For phytoremediation purposes, we have previously observed that the presence of Ocimum basilicum decreased by 37% the concentration of endosulfan in experimentally-polluted soil after 30 days. To study the possible mechanism, we evaluated whether endosulfan could affect 1) the activity of glutathione S transferase (GST) of O. basilicum and its rhizosphere and 2) the community of microorganisms in the rhizosphere. Young plants were added to experimentally-polluted soil with endosulfan. After exposure of a rhizosphere extract to endosulfan at several concentrations in Luria Bertani (LB) broth and agar, microorganism growth was determined spectrophotometrically and by plate count, respectively by triplicate. After exposure of the pesticide endosulfan in O. basilicum and its rhizosphere, three effects were observed: 1. In LB broth, optimal growth of microorganisms was observed at 48 and 72 h after exposure to endosulfan 21 and 30 mg/10 mL, respectively. 2. Optimal growth of microorganisms in cultures exposed to endosulfan LB agar was observed at 3 and 21 mg/10 mL. 3. GST was increased after exposure to these pesticides over its control. These observations suggest that phytostimulaton and bioaccumulation as possible mechanisms of phytoremediation.

SDWS2012.0414 The Clean Energy Industry in Brazil

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Abstract

Clean energy has become increasingly relevant due to society's concerns about the natural environment preservation and to new evidences of environment degradation and climate change. The demand for energy is growing ever faster, and those needs have to be satisfied as increasingly stringent sustainability and security standards are put into force. Therefore, this is one of the most important and challenging sectors in the clean technology industry. In this context, the attempt to explore opportunities has led companies to innovate and improve their positions via new clean energy products and business models. On the other hand, the business challenges in the clean energy sector are considerable, as entrepreneurs have to respond to powerful and entrenched incumbents and to an increasing number of regulations and reputational risks. In that context, this paper draws the partial findings of an on-going research that aims to analyze the characteristics of this industry in Brazil, in order to understand the operational routines and the competitiveness of the sector and to provide information to companies that operate in or want to enter this sector. To achieve the objectives, we conducted a multi-modal study, using a combination of primary and secondary data from semi-structured interviews and publicly available texts such as public reports; policy initiatives; texts of applications for funding; websites and press releases; industry publications and reports; papers; etc. The ongoing results have shown that the clean energy sector in Brazil is dominated by large corporations, many of them multinationals, but also that the number of entrepreneurs has steadily increased in the last five years. Another relevant result is that companies, to operate and influence the energy sector, try to actively participate in industry associations, to establish partnerships with public universities, to participate and organize intra and extra-industry networks, to exhibit at fairs, etc. Considering the vast potential of clean energy in Brazil, we believe that the practical contributions of this paper will assist entrepreneurs, academic, and policy makers to improve the competitiveness and the complexity of the clean energy sector in Brazil.

SDWS2012.0179 Sustainable Economic Growth: a Perspective for Macedonia

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Abstract

Retrospective analysis shows that since 1990's transition economies, including Macedonia, were in deep transition. Transition process was multidimensional and had deep roots. It emphasizes change in economic, social, and political life, and so forth.

According to the official statistics, that does not include shadow economy, during the transition period in all of these economies GDP growth declined and was volatile. Industrial production declined. Furthermore, output in service sector increased while agriculture sector production did not have significant changes. There was no process of reinvestment taking place. Nevertheless, low capacity utilization, depreciation of principal (physical) capital, human capital outflow, slowdown in technical progress, and the missed opportunities for timely changes made the problem of initiating growth even more difficult. In addition to these, inequality in income distribution increased. Social and living conditions of population deteriorated.

The main objective of this research is to identify the composition of GDP, to identify the peculiarity of economic growth in Macedonia and to examine if achieving sustainability and smart growth in long-term is possible. Macedonia can rather be characterized as market-type mixed economy, where a substantial public sector coexists and is dominating. At this point, the discussion on the role of economic growth is of particular importance. It is vital to understand the reasons of low level of capital accumulation in the economy in order to find opportunities to make better use of physical, human and social capital. Furthermore, institutions are needed to set or change the rules of the game and regulate the incentive structure that will lead to growth.

On the basis of the obtained economic growth, correlation analysis is used for investigating the relationship between economic growth and its determinants. Next, OLS regression analyses are used for investigating the relations between determinants such like: gross domestic savings, research and development (R&D), healthcare expenditure, institutional development.

However, it should be noted that because of the poor data availability, the analysis of the relationship is largely exploratory and descriptive in its nature. In order to avoid over-specification and improve model fit, stepwise regression method is implemented. It does not attempt to cover regional-level analyses.

SDWS2012.0195 Sustainable Architecture Inspired by Environment as Contemporary Design Model for the 21st Century

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Abstract

Sensitive architectural solutions respect and should celebrate the environment. This includes an appreciation for the local (geographies, bioregions, seasons, microclimates, etc.) as well as a response to the global (energy sources and resources, etc.). Because buildings are energy consumptive, this is an arena in which architects have the opportunity to innovate, with the aim of achieving "carbon neutral" buildings by 2030 as posed by the Architecture 2030 Challenge.

Environmental dimensions of sustainability (reduced waste, effluent generation, emissions to environment; reduced impact on human health; use of renewable raw materials; elimination of toxic substances) indicate to a particular approach to the project. In the sphere of anthropocentric and non anthropocentric architectural aesthetic and design raises the fundamental question: how to increase the close connection between built structures and environment? Or, which social and political ideas, technologies, materials and type of design should be promoted in order to increase the close connection between built structures and environment?

Learning from the past, learning from other cultures, and taking advantage of technological innovations, architects can design resourceful, delightful environments. Sustainable design methodology aims to define the main criteria, methods and principles, whose implementation is realized positive interactions with internal object, local and global environment in the spirit of sustainable development. The ultimate goal and challenge of sustainable design is the application of best practices that provide quantitative, qualitative, physical and psychological benefits for users of facilities.

Faced with increasingly diminishing resources, creating appropriate architectural environments is beyond choice: it is essential.The aim of this paper is to show that architecture inspired by environment, in the country marked by the ecological crisis, is one of the optimal model of architectural design in the 21st century.

Renewable electricity generation systems I

Keynote presentation

SDWS2012.0455 Current Status of Small Hydropower Plants (SHP) Application in Southeast European Countries

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Abstract

In the project SMART (**S**trategies to pro**M**ote small sc**A**le hydro elect**R**icity produc**T**ion in Europe) from the programme IEE (Intelligent Energy Europe) 7 institutions from 5 European states participate: Province of Cremona – Italy; CESI RICERCA SPA – Italy; Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb – Croatia; Karlovac County – Croatia; Norwegian University of Science and Technology – Norway; Regional Secretariat of Attica - Greece and Energieagentur Waldviertel – Austria. The SMART proposal address to important the non-technological legal/administrative barriers for the expansion of small-scale hydro electricity production inEurope: the lack of suitable support methodologies and tools able to create a clear view of the mini-hydro potential in the territory, the complexity of the legal/administrative processes to obtain concessions, the economical/financial attraction of private investors. Main objective of project is to give clear contributions to pull down these non-technological barriers, as helpful tools for European, national, regional and local authority decision-makers for increasing the implementation of small-scale hydro electricity plants (SHP). Therefore, the partners are analyzed the normatives about SHP in different EU countries (both in partners countries and in the neighboring countries), giving the general overview of the situation of SHP implementation, institutions responsible for making and executing acts (laws), rules, permissions and procedures, review of the normatives and mention to forms of state support for SHP electricity production. Now in this paper, the results of this analyse for Southeast European Countries (Croatia, Bosnia and Herzegovina, Serbia, Monte Negro, Bulgaria, Romania, Macedonia, Albania and Greece) will be presented. Also in the paper, both the inalienable principles (a mention to competing uses of water) regarding the right to use water and the authorization of SHP and kinds of permits in mentioned countries will be presented. On the basis of critical review of different regulations, the weak and the strong points of different regulations and most important conflicts related to the use of water will be determined. On the end, strategies, recommendations, methodologies and tools to improve the existing regulations and pull down the non-technological legal/administrative barriers will be proposed.

SDWS2012.0573 Short Term Wind Speed Prediction Using Multi Layer Perceptrons

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Abstract

Among the renewable resources the one that had a faster technological innovation and a more rapid diffusion is wind energy. Power generated by wind turbines depends on the consistence and time distribution of wind in the area under consideration. Therefore a good knowledge of the characteristics of the wind is a prerequisite for good planning and construction of any wind power project. Conventional statistical methods aims to seek the relationship between site climatic data and wind resource availability in order to assess the long term production. Anyway the simple knowledge of statistical wind speed data is not sufficient to calculate wind power profiles and the energy production available in a site in short time periods (i.e. hours or days). Because the wind is an intermittent resource the power generated by a wind farm varies rapidly. It is well know that the fluctuation of wind power generation in many cases caused problem of grid stability. For these reasons it is crucial to develop forecasting tools to predict wind speed and the wind energy production in the short term. The learning approach, based on artificial neural networks, is an approach complementary to the statistical tools which allows to predict wind speed. There are several kind of neural networks available in literature but in this study the Multi Layer Perceptrons (MLP), also called feed forward network, has been used for predicting the wind speed. Different configurations of MLP based on variable number of layers and neurons have been investigated. Three different configurations, with single or double hidden layers (and with a different number of neurons), were verified. Input data provided to the networks are the wind speeds recorded by two anemometers placed in the same area. The forecast processing was carried out for different time steps, from zero to five. In a first phase of this study, data collected every ten minutes, have been used. In a second phase, data of ten minutes sampling have been averaged on hourly basis. In order to identify the best model the mean square error (MSE) has been calculated starting from the validation phase of the MLP. Generally, the simplest configurations have obtained better performance during training and testing phase, reflecting the persistence of the wind in the area where the data was collected. Increasing the complexity of the network and the number of the input the MSE assumed highest values, however, remaining under the threshold of 15%.

SDWS2012.0191 Analysis of Energetic and Exergetic Efficiency and Environmental Benefits of Biomass Integrated Gasification Combined Cycle Technology

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Abstract

Motivation

Environmental strategies derived from the necessity of reducing green-house gas emissions reduction promote the research on combustion of biofuels as totally alternative fuels for power generation. Compared with external combustion or co-combustion with coal of either biomass or processed biofuels, power generation through gas turbine operating in combined cycle allows a high efficient use of biomass energetic capability. Gasification of biomass is particularly of interest for obtaining a biofuel to run gas turbines since it is the most efficient biomass-to-biofuel conversion process and it presents additional advantages as the possibility of adding a CO_2 precombustion capture unit.

Objectives

The goal of this work is to simulate and analyze the behavior on service of biomass Integrated Gasification Combined Cycles (IGCC) for power generation using substrates of different origin (herbaceous energy crops, wood biomass, agricultural residues, municipal solid waste, other residuals...).

The power plant is simulated for the considered set of substrates. The difference in performance are studied from different points of view in relation with the current complex energetic context: energetic and exergetic efficiency of the overall biomass-to-power process, CO_2 emission avoidance potential with and without CO_2 precombustion capture, availability of biomass resources and economical cost of the generated electric power.

Methodology

Calculations for the power plant have been carried out, considering the commercial turbines and other devices that are more adequate for the optimized conditions of the cycle. A complete analysis has been carried out using Thermoflow's GT-PRO, a software tool that includes a huge database about gas turbines nameplate characteristics.

Main results and conclusions

Although significant technical development is needed, the use of biomass IGCC for power generation is a very promising technology with a high growth potential. It is a high efficient procedure to obtain large amounts of energy from a renewable and CO_2-free source. Furthermore, contrarily to other renewable sources, biomass IGCC power plants could work as base energy supply with the same capacity factor as conventional thermal plants, if biomass supply is ensured.

SDWS2012.0253 Performance Analysis of a Grid-Connected Six-Phase Induction Generator for Renewable Energy Generation

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Abstract

This paper presents the detailed performance analysis of a grid-connected asymmetrical (30^0 displacement) six-phase induction generator (GCSPIG) driven by hydro turbine for renewable energy generation. A purely experimental treatment is provided with the emphasis placed on operating regimes that illustrate the advantages of using a GCSPIG. In particular, it is shown that the GCSPIG can deliver power to two independent entities (one utility grid and other isolated load) which represents an additional advantage. While the interaction between the two winding sets is inevitable and variation of load at one winding set changes the operating conditions at the other winding set, the situation is still satisfactory for a wide range of rural resistive loads. Last but not least, outputs of the two three-phase windings can be used to deliver power to utility grid through an interconnecting Y-D/Y six-phase to three-phase transformer, in which case failure of one three-phase winding does not lead to the system shut down and the power can still be supplied to grid from the remaining healthy winding. Experimental results include study of steady-state behavior of GCSPIG when (i) one three-phase winding is connected to grid and other three-phase winding is open, (ii) one three-phase winding is connected to grid while other is connected to an isolated load, and (iii) when both the three-phase winding is connected to grid. It is shown that machine can feed direct, reliable, and low cost power to grid without interface. From detailed performance analysis, it was found that GCSPIG is able to deliver more power (150-176 %) to grid as compared to its three-phase counterpart leading to more power to weight ratio.

SDWS2012.0517 Performance of Locally Manufactured Small Wind Turbines for Rural Electrification Applications

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Abstract

The development of a new concept in small wind energy systems is presented, discussed and tested in this paper, namely that of open source hardware (OSH) small wind turbines for rural electrification applications. This technology provides the ability of locally manufacturing small wind turbines, which in turn enhances socially sustainable and technically reliable village electrification, while at the same time reducing greenhouse gas emissions and enhancing local small scale economies.

The technology was tested in the Electrical Energy Systems laboratory of NTUA in order to validate and improve its performance and discuss its suitability in the rural electrification context. Several OSH small wind turbines of rated power ranging from 250W up to 3kW have been constructed with the participation of undergraduate students in the workshops.

The most significant parts of the small wind turbine, the rotor blades and the generator were tested in laboratory conditions for validation of their performance. The rotor was tested in wind tunnel tests and the generator was tested in bench tests while driven with a DC variable speed motor. Important characteristics of the generator such as its efficiency were measured experimentally and its overall behaviour was validated. The aerodynamic power coefficient of the rotor was measured experimentally in the wind tunnel tests. For more accurate results, outdoor fields tests were conducted for the period of one year in order to measure the power curve and overall efficiency of the small wind turbine under real conditions, according to the IEC 16400-12-1 power performance tests.

The results of the tests proved that these small wind turbines can provide quality production of electrical power from the wind and at a lower cost for the user, since the initial capital required is one third that of a commercial small wind turbine. The design was developed further and improved with low cost optimizations of the generator which resulted in improved designs with respect to their Euro/kW cost, while the combinations of rotor diameter and tower height for locations with different roughness, were optimized for low cost and best practice tables were produced.

In conclusion, the emerging technology of OSH small wind turbines was tested, validated and improved in order to provide additional scientific information on the technical aspects of this technology, only to come as an addition to its positive social, environmental and economic effects.

SDWS2012.0376 Theorical Comparison of a Horizontal Small Wind Turbine with Ball and Magnetic Bearings on the Starting

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Abstract

The use of magnetic bearing on mechanical and electrical machines has been increase on the last 5 years, besides that the research about them have a background of 25 years. Some commercial machines like the maglev chiller of McQuay which use a technology based on magnetic bearings shows an increase on their efficiency of 30% on their starting. The development of this technology is looking for increase efficiency, low noise, vibration, friction and the maintenance. Despite this, it is a young line of research; there are many applications that can be exploited, one of them are the wind turbines for generation of electrical energy.

This paper describes the theorical comparison of a 500 Watts small wind turbine with a NACA 2418 airfoil type during star-up for two proposed systems. The first one considers a system with ball bearings which offer a friction moment. The second one is a system where the ball bearings are replaced for magnetic bearings that the friction is negligible. The mathematical model was developed for the both systems based in the government equation at starting condition. The results showed that there is an increase in power output of 11% with a wind turbine using magnetic bearings and a dash of 12.85 seconds faster, finally also shows that wind turbine with magnetic bearings starts to produce electricity at lower velocity than ball bearing.

To perform this comparison were taken into account the following subsystems of the wind turbine. The first subsystem consider the aerodynamic of the blade, a second subsystem is the mechanical transmission specifically the bearings and shaft, and finally the electric subsystem that contemplate a permanent magnet generator (PMG) and his power output. Beside that another consideration likes the material density of the blade and the geometry. The friction and resistive torque of a ball bearing was also considered. On

the PMG regard another resistive torque better known like cogging. At least also is taken into account the moment of inertia of all components.

For the starting behavior for the wind turbine was used the methodology approach by P.R. Ebert et al, also the magnetic bearing theory is applied, using the information available from Schweitzer and Kurita. Where it is used the aerodynamic geometry of the blade which was previously designs. These methodologies were modified to obtain variables like the revolution per minute, time to start of the wind turbine and power output. The results are compared between the two systems.

The final results show that the use of magnetic bearings make a wind turbine 11% more efficient on energy generation also the starting time is reduced on 44% for nominal wind velocity. Beside that the starting wind need to start up the small wind turbine is reduce from 3.5 m/s to 2 m/s. These final result shows that is possible to use more wind energy and increase the capacity factor (plant factor).

Transport

Keynote presentation

SDWS2012.0461 Use of Carbon Calculation Tools for Sustainable Cycle Network Design

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Abstract

Current commuting patterns in Ireland are unsustainable. 1.1 million people (58% of the commuting population) drive a car to work every day and only 36,000 people (2% of the commuting population) cycle. This is despite the fact that 30% of commutes are less than 5km – a reasonable cycling distance. To encourage a modal shift to cycling, the Irish government has introduced a range of measures including the establishment of a National Cycle Network (NCN). The NCN will be formed by a range of cycle route types including: (i) on-road; (ii) cycle lanes; and (iii) greenways (traffic-free cycle trails). The carbon emission for an average Irish passenger car is approximately 160 g CO2/km and emissions from all Irish passenger cars totalled 5.8 million Tonnes CO2 in 2009. A modal shift to cycling has major potential to reduce Ireland's carbon emissions, however, the climate cost of constructing new cycling routes, particularly greenways, has not been previously considered. This cost has the potential to negate the carbon savings made by the modal shift of many commuters. This will be particularly relevant in rural areas where a greenway has been constructed (perhaps due to dangerous traffic and poor road quality), yet usage is low, i.e. the carbon cost is distributed over few Passenger Kilometres Travelled. Carbon emissions from pavement construction are a result of the materials (asphalt/concrete, aggregate etc.), machinery, construction method, transport of materials, water and power used etc. This has been modelled for highways in tools such as asPECTand PaLATE. Evaluating the carbon emissions in the construction of cycle route pavements has a major role to play in the route selection and design phases of the formation of the NCN. Currently, no guidelines for cycling route selection exist in Ireland, however this study has established international best practice for the design of off-road cycle routes. For the effective comparison of such route options, a metric for the environmental impact of each route is necessary. This study develops such a metric to calculate the carbon emissions and savings associated with each route. Such a metric will form part of an overall cycle route design matrix currently being separately developed as part of this study. This paper (a) calculates the potential carbon savings of a modal shift to cycling in Ireland; (b) models the carbon cost of the three key cycling route types; and (c) combines the results of (a) and (b) to develop an environmental metric for quantifying the carbon efficiency of cycle routes. The environmental metric developed by this paper may

be used in an overall design matrix for the comparison of route options, yielding the efficient and environmentally friendly design of cycle networks. The metric, once optimised, can be applied to cycle routes being planned and constructed internationally.

SDWS2012.0539 The Feasibility of Synthetic Fuels in Renewable Energy Systems

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Abstract

The transport sector is one of the most important sectors of our time, as well as a significant carrier and the backbone of economic and social development of each country. At present, the transport sector is the only sector in which there have been no significant renewable energy penetrations and it is heavily dependent on oil. It is clear that transport cannot develop along the same path in the future. Biofuels are proposed as the main option for replacing fossil fuels in the transport sector, along with electricity. The main reasons for avoiding the direct usage of biomass in the transport sector, i.e. producing biomass derived fuels, are land use problem, resource use, interference with food supplies, and other impacts on environment and biosphere. The purpose of this article is to identify potential pathways for producing synthetic fuels, with a specific focus on solid oxide electrolyser cells which are combined with the recycling of CO2 to produce synthetic fuels. Two pathways are proposed to achieve a 100% renewable transport sector - co-electrolysis of steam and CO2 and hydrogenation of CO2. Proposed production processes of synthetic fuels do not include direct usage of biomass and facilitate potential independence from the geographical and supply related issues of conventional fuels, while electrolysers provide stability of the electric grid by enabling integration of intermittent renewable sources. With captured CO2 from atmosphere proposed production process of synthetic fuels could enable a closed-loop carbon-neutral fuel cycle. These scenarios have been compared with two pathways that have direct usage of biomass in a production process of liquid fuels - hydrogenation of biomass and conventional biodiesel pathway. The analysis showed that the synthetic fuel scenarios increase the system flexibility and this is essential for the conversion of the energy system into a 100% renewable system. The costs of synthetic fuel scenarios are more expensive, but biomass savings associated with this make the additional costs worthwhile due to the scarcity of biomass for the energy system. With feasible technological development and mass production of the Solid Oxide Electrolyser Cells, synthetic fuels could be competitive and have market advantage

over biomass derived fuels based on their supply related issues, land use shortage, limited biomass availability, etc.

SDWS2012.0058 A Well-To-Wheel Analysis of Electric Vehicles in the All-Island Single Electricity Market

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Abstract

The European Union has set a target for 10% renewable energy in transport by 2020, which will be met using both biofuels and electric vehicles. In the case of biofuels, for the purposes of meeting the target, the biofuel must achieve greenhouse gas savings of 35% relative to the fossil fuel replaced. For biofuels, greenhouse gas savings can be calculated using life cycle analysis, or the European Union default values. In contrast, all electricity used in transport is considered to be the same, regardless of the source or the type of electric vehicle. However, the choice of the electric vehicle and electricity source will have a major impact on the greenhouse gas savings. In this paper some WTW studies for EVs are examined and a well to wheel analysis of the all-island single electricity market of Northern Ireland and the Republic of Ireland is presented. The paper is divided into four main sections. Firstly, the well to tank, tank to wheel and well to tank technical terminologies are explained. Secondly, the existing well to wheel studies are overviewed and compared. Then thirdly a well to wheel analysis of the test system is provided. Finally, there is a discussion and conclusion section and the next stage of this research is set-out.

SDWS2012.0552 Energy Policy and Long Term Energy Demand of a Transport Sector: Case Study Croatia

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Abstract

Transport sector in Croatia represents one of the largest consumers of energy today with a share of almost one third of the final energy demand. That is why improving energy efficiency and implementing different mechanisms that would lead to energy savings in this sector seems relevant. Through this paper long term energy demand projections of Croatian transport sector will be shown. Special emphasis will be given to different mechanisms; financial, legal but also technological that would influence future energy demand scenarios. Energy demand predictions are based upon end-use simulation model developed and tested with Croatia as a case study. Model combines detailed modal structure of Croatian transport sector including road, rail, air and water transport modes. One of the additional features is the intermodal forms of transport which can be important parameter in energy demand modeling. Based on its importance regarding Croatian energy balance, transport sector represents important part of Croatian energy strategy. One of the major conclusions shown in this paper is significant possibilities for energy efficiency improvements and lower future energy demand, based on careful and rational energy planning.

SDWS2012.0471 Assessment of Climate Change Mitigation Potential of the Macedonian Transport Sector

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Abstract

The transport sector in Macedonia is highly polluting and in critical need for transfer and diffusion of improved technologies, low carbon fuels, as well as changes in travel behavior. According to the National Greenhouse Gas (GHG) Inventory, prepared for the purpose of the Second National Communication under UN Framework Convention on Climate Change, the contribution of the transport sector is about 10% of the total emissions. Furthermore, the National Energy Strategy projects a dramatic increase in vehicle use, starting with 17 vehicles per 100 residents in 2010 and reaching 26 and 40 in 2020 and 2030, respectively.

This paper comprises a comprehensive assessment of climate change mitigation potential of the national transport sector, evaluating appropriate options in line with three mitigation strategies: Improvement of vehicle fleet; Introduction of low carbon fuels; and Improvement in travel behavior:

The evaluation is performed using GACMO costing model, which compares each mitigation option with the baseline and determines its environmental effectiveness (t CO_2 reduced) and economic effectiveness (US$/t CO_2 reduced). The resulting marginal cost curve indicates a total achievable reduction of about 20% with respect to baseline GHG emissions of the transport sector.

Although with relatively low environmental effectiveness (reducing the baseline emissions for less than 2%), a third of the considered options are of win-win type, which is partially explained by the outdated and inefficient buses and cars used currently, as well as limited use of the public transport. Options with largest mitigation potential are connected with the required shift towards low carbon fuels. Still, they appear difficult for implementation, mainly due to the lack of financing, as well as legislative and administrative barriers. Economic policies, which strive to modify the behaviour and the decision criteria of the stakeholders, as well as administrative policies, which focus on the necessary regulations are prerequisite for achieving the estimated emission reduction.

SDWS2012.0600 The Use of Numerical Simulation for Prediction of Pollutant Emissions in Diesel Engines

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Abstract

Diesel engines power most of the world vehicles and release great amount of pollutants that affect environment and human health. Knowing that fact, it is necessary to lower pollutants such as NO_x, soot, CO and HC to a minimum value. Numerous investigations are used to determine how various factors like design, fuel injection, fuel-air mixing, combustion etc., influence pollutant emissions. The understanding of these complex processes in experimental investigations is limited and this understanding can be significantly improved by use of numerical modeling and simulations. This paper shows how numerical simulations in combination with existing experimental data can be used for good prediction of pollutant emissions released from internal combustion diesel engine. The results of numerical simulation are compared with experimental data.

Energy policy II

Keynote presentation

SDWS2012.0340 Dealing with the Paradox of Energy Efficiency Promotion by Electric Utilities

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Abstract

Utility-based Demand-Side Management (DSM) programmes started after the oil crises of the 70's, although only designated as DSM in the 80's, as information campaigns and loan programmes. The financial incentives to induce more solid energy saving choices were a strong tool for utilities, when engaged in integrated resource planning (IRP), where DSM alternatives are considered on an equal footing to supply-side options. In order to increase savings and participation, a more committed involvement of utilities was necessary: a "market transformation", a change in the energy service and the conversion technologies, so that the more efficient equipment were the norm.

In the early 1990s, DSM programmes were already standard practice for many utilities, changing their business to also include provision of energy services. The deregulation of the electricity industry, which was occurring at the same time, threatened DSM, due to lack of funding, allegedly to avoid market distortion. Against some expectations, the liberalization of the electricity sector did not have a catalytic role in the creation of an energy efficiency (EE) market. After the California energy crises in the winter of 2000/01, utilities focused on programmes with short-term results. Energy Efficiency Resource Standards arise as a market-oriented mechanism requiring utilities to achieve certain energy savings targets through EE. In some European countries the savings obtained by utilities can be certified, and a "white certificate" is issued. This is the case of the Flemish region of Belgium, Denmark, France, Italy, and UK, alongside with Canada and New South Wales, in Australia.

Fostering EE is an issue that cuts across various sectors of the society. An example is the participation of non-utility proponents in calls for energy savings proposals of a Portuguese tender mechanism developed by the energy regulator where, for the last three calls, the number of proposals increased 21% while the number of measures proposed by utilities decreased 13%. Other interesting facts are the increasing financial contribution of utilities to the measures they proposed (from 0.3% to 12%) and the reduction of the consumers contribution to those same measures (from 28% to 23%). Investing in EE measures, even without recovering the costs, is nowadays adopted by utilities in

competitive environments, assuming a potential reduction in sales as a cost of customer retention.

Different approaches have been adopted to deal with the paradox of utilities involvement in EE fostering: regulatory impositions, sharing of costs and benefits, plain utility's marketing strategy.

The option for using legal/regulatory frameworks that lead utilities to foster the efficient use of energy must ensure their economic and financial balance as well as maintain, or even improve, their competitiveness.

SDWS2012.0107 Economic Assessment of Roof-Top Photovoltaic Potentials: Analyzing Efficiency Losses Due to Suboptimal Location Decisions

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Abstract

Over the last decade, solar photovoltaic (PV) has become a technically feasible source of renewable energy. Furthermore, PV has also become economically interesting due to steadily decreasing cost, but it still depends on governmental funding in order to be competitive. In many cases, PV installations on the roof of private residential buildings are preferred over ground-mounted options as generation is close to consumption and competition for land resources is limited. Although the share of PV in the energy mix is small in Austria, investment subsidies and feed-in tariffs have led to cumulated tariff-funded PV installations of 154 MWpeak in 2010. The federal state of Vorarlberg additionally provided substantial investment-funding for PV, which increased its total capacity to around 34 MWpeak and thus represents the highest density of PV per capita in Austria. However, there are no regulations regarding the decision which roofs are subject to subsidization. It can be assumed that private households make optimal investment decisions and only invest in PV installation on their roof, if the return on investment is expected to be high enough. Yet, there are no estimations whether these individual decisions are in line with coordinated cost-effective energy production, or not. The aim of this paper is to assess efficiency losses implied by non-optimal distribution of PV

installations in Vorarlberg. Therefore, we use the solar cadaster developed by the research institute Laser-Data as well as a digital surface model to consider orientation, inclination and shadowing of roof areas in estimating the technical PV production potentials for all roofs in Vorarlberg. The application of a techno-economic optimization model allows identifying the cost-effective roofs for PV energy generation for a given power production quantity. In order to quantify inefficiencies due to suboptimal PV deployment, data on real installations subsidized by the federal government are compared with the modeled cost-effective locations. The model outcomes will not only reveal missing regulations on the deployment of roof-top PV installations, but also present highly favorable locations for further installation.

SDWS2012.0147 Energy Efficiency Road Mapping in Three Future Scenarios for Lao Pdr

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Abstract

Energy efficiency is one of the important issues for developing countries. There are no exceptions in East South Asia. Lao PDR is one of such countries. Lao PDR is a member of GMS (Great Mekong Sub-regions) and has a population, 6,320,000 in 2008, looks growing to date. In general the energy demand increases in proportion to population, so it becomes a relatively big issue for Lao PDR to meet the supply in an efficient way responding to the energy demand in future.

This paper aims to make the Energy Efficiency Roadmap in Lao PDR with the consideration of a wide range of economic and social impacts of prospective technologies. What is well known as “energy efficiency” in advanced countries rather implies saving energy consumption, but this may not often be applicable in developing countries like Lao PDR. Then, we focus on loss reduction in energy supply rather than energy conservation in demand side. The study of the status quo and the trend is divided into two aspects - technological and institutional, both of which are devoted to the implementation of technology assessment.

For the implementation of technology assessment in the formulation of energy efficiency roadmap, we firstly elaborate social and economic conditions of Lao PDR through the preliminary research and field research, and then design three scenarios for future Lao PDR. These scenarios are rather extremes, not faithfully reflecting future possibilities in

this country, but by so doing this opens up a wide range of courses Lao PDR can take. The three scenarios are, 1. “Catch Up” scenario is for stable domestic energy supply, 2. “Poverty Reduction” scenario is for Electrification rate improvement and 3. “Battery of ASEAN” scenario is for Acquisition of foreign exchange by energy export.

These three scenarios cannot be independent and autonomous even when social decision-makers have decided to take one of these. Based on the roadmap integrating the aforementioned technology landscape and technology assessment, the project proposes the Energy Efficiency Roadmap in Lao PDR. As a result, loss reduction, particularly system loss reduction in supply side is crucially important at this current energy situation. To achieve loss reduction, we depict three scenarios and point out poverty alleviation is essential element to achieve virtuous cycle between “catch-up” and “foreign currency acquisition”. This cycle should proceed in the context of poverty alleviation escaping from Least Developed Country by 2020, which will provide the energy efficiency potential in demand side.

SDWS2012.0144 A Time Extended Definition of Land Use as Metric for Sustainability in Electricity Generation

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Abstract

When comparing renewables with fossil fuels, emotional approaches are fueled by the difficulties in defining a proper metric able to make consistent comparisons. In literature several approaches have been proposed, all effective in some way but ineffective in others. Variables like energy density, prices, estimated resources, life time emissions, water use and waste, all come at the same time to form an unmanageable mix. Nevertheless, the adoption of a shared metric is essential to clarify the boundary conditions that limit the solutions we can operate and to define which scenarios are sustainable and which are not. This paper support the view that power density, as proposed by Smil, is the most powerful parameter in evaluating the variety of energy technologies and, moreover, it highlights the key limitation in size of available land which play its role in limiting both the amount of available resources but also the carbon sequestration capability of the planet. The future land use, a further extension of land use definition, will be proposed putting the time variable into play in order to deal with the lasting side effects of each energy option, like fossil fuels emissions and nuclear waste. In the latter case, the time variable comes in also trough the issue of the preservation of sensible information. Eventually a definition of a unique parameter will be proposed and figures to pros and cons of all energy options will be calculated and put in a single

graphic. The overall picture shows from one side the distressing low values of power density of renewables but, on the other side, make clear the incompressible limitations at which non renewables sources can be exploited.

SDWS2012.0105 Policy Options Evaluation of Current Thermal Power Retrofit with CCS Technology

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Abstract

For China and some developing countries, a large proportion of thermal power plants (most of them are Pulverized Coal, PC) were built after 2000s which still have several decades of lifetime before retirement. Although it is more costly to retrofit existing thermal power with CCS than to construct a new power plant with CCS, no one can ignore the great potential that these existing thermal power plants will make large contribution to greenhouse gas emission reduction if such plants can be retrofit with CCS. For the government, it may also be necessary to have some policy support (e.g. subsidies) to incentive such retrofitting investments.

As most Pulverized Coal power plants can be retrofit with post-combustion capture technology. In this paper, we are trying to discuss the following questions: whether it is worth to invest in such CCS retrofitting, how to measure the value of such investment, and which policy is more effective if the government want to promote the development of CCS retrofitting?

This paper applies real options theory to establish a CCS sequential investment evaluation model which focuses on the evaluation of retrofit existing thermal power with CCS technology. The model is based onMonte Carlosimulation so it can consider several CCS technical and economic uncertainty factors (fuel price risk, carbon price, CCS technology uncertainty, and thermal power with CCS generating cost). With the uncertain cost-benefit comparison between existing thermal power and thermal power retrofit with CCS, we have modeled the cost saving cash flow and evaluated the value of the cost saving effect for enterprises investing in CCS technology to retrofit existing thermal power. Our model is solved by the Least Squares Monte Carlo (LSM) method.

Our case study is focused in China which is a representative country with coal-dominated energy consumption, and a typical thermal power plant (600 MW Super Critical Pulverized Coal, SCPC) which has already been put into use in China is taken as a case study to evaluate the value of investing in CCS retrofitting. Since the model could be used

as a policy analysis tool, the effects of different forms of government subsidies (R&D subsidy and generating subsidy) on CCS retrofit investment have been introduced and compared in the model.

The computation results show that, currently, the investment risk of retrofitting existing thermal power with CCS is large. There is an important trade off between reducing greenhouse gas emissions and protecting the interests of power generation enterprises. And with the comparison between government's R&D subsidy and generating subsidy, if China has to promote GHG emission reduction to a greater extent, it is necessary to subsidy power generation enterprises for their retrofitting existing thermal power with CCS, and given the same level of total financial input, it will be a little better for government to promote R&D subsidy than generate subsidy.

SDWS2012.0504 Consumers' Preferences Towards Financial Support Instruments for Residential Energy Efficiency

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Abstract

Households in Croatia are responsible for almost 30 percent of total country's final energy demand and 40 percent of electricity demand. In addition, existing residential building stock has poor energy performance with heating requirements typically exceeding 200 kWh/m^2. Moreover, with inevitable increase in energy prices, already significant problem of energy poverty in Croatia will further rise, and traditional social policies will not be able to tackle it effectively. Despite all of these facts which are putting households in the focus of national energy efficiency policy, the systematic energy efficiency activities and support instruments directed towards households are still missing in Croatia leaving the huge potential for energy and cost savings idle. High up-front costs of residential energy efficiency improvement measures, lack of access to the capital for home owners and low energy prices causing long pay-back periods for residential energy efficiency investments are identified as the most important barriers.

As shown in countries with more advanced energy efficiency policy, state support to energy efficiency measures in households is crucial for their successful implementation. Additionally, the very nature of energy efficiency calls for a bottom-up approach,

requiring individual commitment and a clear public understanding of the issue. Therefore, the participation of the public, in creation of support instruments for residential energy efficiency is deemed useful and necessary. The aim of the research presented in this paper was, therefore, to investigate citizens' attitudes towards possible financial support instruments and to identify and recommend policy makers those instruments having the largest public acceptance, hence potentially the largest impacts in terms of energy savings.

A public opinion survey was prepared with two major groups of questions providing the following information: (i) current levels of energy consumption, related costs and energy efficiency in households and (ii) plans to implement energy efficiency improvement measures and desirable financial instruments that would lead to the actual realisation. Public survey was conducted mainly on the Internet and partially in the field for those groups which are less likely to use online tools, i.e. unemployed and retired. The survey has gathered more than 1800 answers. This paper will analyse the results of the conducted survey and discuss the possible policy solutions which would lead to increased willingness to undertake energy efficiency improvements in households.

Buildings I

Keynote presentation

SDWS2012.0419 Towards Zero Emission Buildings: the State-of-the-Art of National Regulations in Europe

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Abstract

Energy consumption in residential and commercial buildings represents around 40% of total final energy use and is responsible for 36% of the European Union's total CO2 emissions. Therefore, reducing the building energy demand and increasing the penetration of renewable energies are important and relevant measures in order to reduce the Union's dependency on fossil fuels and greenhouse gas emissions.

The 2002 Energy Performance in Buildings Directive (EPBD) and its 2010 recast set out the framework of ambitious targets to achieve the entire energy-saving potential of the building sector. These targets are consistent with those expected from other relevant cross-sectional directives (e.g. Eco-design of the Energy-Related Products Framework Directive 09/125/EC, the End-use Energy Efficiency and Energy Services Directive 32/2006/EC and the Labelling Framework Directive 2010/30/EU).

Against this promising framework, some studies report large differences between results achieved by European Member States in improving energy efficiency in the building sector. In particular, nearly zero-energy building (NZEB) initiatives seem to be jeopardized and supported more on random than systemic basis.

Scientific literature reveals a lack of clarity of the underlying determinants of the evolution of NZEB initiatives.

The aim of the present study is to provide a comprehensive overview of the current national regulatory framework, in each Member State, focusing on three specific and strategic aspects: integration of targets for renewable energies into the regulation for energy efficiency in buildings, measures for linking energy performance of buildings with their commercial value, application of economic measures (e.g. penalties for non-compliance, incentives for continuous improvement of energy performance in buildings, etc.).

An European survey was performed using a questionnaire, which was sent to 27 Member States.

The answers to the inquiry showed an heterogeneous outcome both in terms of measures and tools. This heterogeneity strengthens the importance of coupling the adoption of the EPBD recast at national level and the best practices cross-fertilizations among Member States.

The results support the conceptualization of integrated regulation as a driver of energy efficiency in building sector.

SDWS2012.0145 Performance Implications of Heat Pumps Participating in Demand Side Management

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Abstract

This work considers the potential impact of participating in demand side management on the energetic and carbon emissions performance of air source heat pumps.

In order to achieve significant reductions in carbon emissions, it is widely envisioned that electrification of UK heating and transport sectors will need to be combined with decarbonisation of the electrical supply. Altering the temporal characteristics of the electrical demands (demand side management) has been suggested as an option to mitigate some of the challenges associated with matching an increasingly intermittent supply to increased demands and associated with limitations in the capacity of local distribution infrastructure.

Models of variability in wind generated electricity and typical climate for 2030 are combined with data and models of other demands to illustrate the effect that different control ideologies and priorities are likely to have on the overall seasonal performance of air source heat pumps. Heat pumps with performance characteristics of current units are considered along with that which would be achieved with the range of exergy efficiencies likely to be widespread by 2030.

It is shown that low to medium interventions in the control of the heat pumps (associated, for example, with medium estimates for 2030 wind generation capacity) can be tolerated without significant effect on the performance of the heat pumps. As larger interventions are required the total electrical consumption starts to increase dramatically even whist

non-renewable primary energy consumption of the heat pumps is reduced. These effects are less marked if heat pumps with a higher nominal performance achieve higher market share or if the thermal time constant of buildings is significantly increased. It is unlikely that widespread adoption of heat pumps can be achieved without some distribution network reinforcement; however the level of management required to minimise this reinforcement is unlikely to affect performance.

The study was funded under EPSRC's SUPERGEN HiDEF project (EP/G031681/1)

SDWS2012.0446 Sensitivity Analysis for a Portuguese Windows Energy Rating System (PWERS)

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Abstract

Energy consumption in buildings has increased 7% per year since 1990 and accounts for 29% of energy end-use in Portugal. Fenestration plays an important role as one of the main sources of heat exchange between a building and the external environment. Different windows energy rating systems (WERS) are being developed in various countries, depending on local climate characteristics. Most European models of WERS focus essentially on the heating season when the solar factor and thermal transmittance play a leading role in the rating system. Since Portugal is in a Mediterranean climate zone, the behavior of windows during the cooling season is important. Therefore the Portuguese windows energy rating system (PWERS) must take into account both the windows' characteristics and the performance during the heating and cooling season, so that a global performance is achieved. For this, thermal simulations are needed to estimate the heating and cooling behavior over the whole year.

This paper describes several simulations that were performed for different weather data for Portugal. The calculations take into consideration the windows' solar factor, the thermal transmittance, the orientation, the air tightness/air permeability, the solar shading and window/floor area ratio. Finally, a sensitivity analysis is performed on the results in order to be considered in PWERS development.

SDWS2012.0582 Net-Zero Targets for Increasing Rational Exergy Management in Buildings and Districts

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Abstract

This paper analyzes the nexus of exergy, net-zero targets, and sustainable cities as a means of analyzing the role of exergy-aware strategies at the building, campus and district level.

The first case study is a premier building in Ankara that is ready to meet the net-zero exergy target. It is also the first building in Turkey to receive the highest Platinum rating in Leadership in Energy and Environmental Design. A net-zero exergy building (NZEXB) is a building that has an annual sum of net-zero exergy transfer across the building-district boundary. This new target is made possible by lowered annual exergy consumption, AEXC, and increased on-site production from a bundle of sustainable energy technologies. The modeled results of the building indicate that the reduced AEXC of 60 kW h/m^2 yr is met with on-site production of 62 kW h/m^2 yr. On-site production includes PV and building integrated PV, a micro-wind turbine, combined heat and power, GSHP, and solar collectors. Diversified thermal energy storage tanks facilitate the exergy supply to meet with the exergy demand.

The results of this case study provide key lessons to structure an energy value chain that is more aware of exergy, which are up-scalable to the district level when the bundle of sustainable energy technologies is zoomed out across a larger spatial area. These key lessons are then compared with the case studies of a university campus in Ankara and two districts in the south heating network of the city of Stockholm, which was the European Green Capital in 2010. The levels of exergy match in these districts of Stockholm, namely the districts of Högdalen and Hammarby, is found to be 0.82 and 0.84, respectively. However, there remain several bottlenecks for these districts to reach net-zero targets at the community level.

The paper concludes that the NZEXB case study has much to offer as a ‘‘building block’’ to reform the way energy is converted and managed and in this way, to structure an exergy-aware energy value chain for greater sustainability in the future.

SDWS2012.0519 Esstimating the Marginal Cost and Environmental Effectiveness of the Climate Change Mitigation Measures in Public Buildings in Macedonia

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Abstract

A case study approach is applied in order to evaluate climate change mitigation measures in the public building sector under the municipal authority. Starting point of the analyses are the findings and data gathered in the frame of the project "Mitigating climate change through improving the energy efficiency in building sector" implemented by UNDP Macedonia. Analyzed data presents the overall inventory of the public buildings above 1000m2 under the local government's authority in the country. The applied evaluating model is RetScreen, which compares each mitigation option with the baseline and determines its economic and environmental effectiveness. The study is assessing the greenhouse gas emissions from the public building and identifying the reduction potential of greenhouse gas emissions by implementation of energy efficiency measures in public buildings. Moreover, analyze of the public building sector is conducted in terms of energy efficiency and least cost optimized measures are recommend for specific types of model buildings. Almost all of the considered measures are shown to be of win-win type, which can be partially explained by the high energy intensity of the national economy, although their environmental effectiveness is relatively low. On the other hand, options with the largest mitigation potential are shown to be most difficult for implementation, mainly due to the lack of financing and capacities at the municipal level, as well as legislative and administrative barriers. The study can be used as a basis for development of a reconstruction programme for specific types of public buildings on national level.

Recycling waste

Keynote presentation

SDWS2012.0371 An Alternative to Phosphorus - Ecological Sanitation as a Feasible Option in Agriculture

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Abstract

The goal of this paper is to present ecological sanitation, i.e. dry sanitation and nutrient recycling, as a feasible option for fertiliser use in agriculture instead of mined phosphorus. Examples will be studied from developed and developing world.

Phosphorus is an essential nutrient for plants to grow. Traditionally phosphorus was part of the closed cycle, when nutrients of manure were used to fertilise crops. In modern agriculture, manure and organic fertilisers are replaced fully or partly by chemical manufactured fertilisers. In order to manufacture these fertilisers, phosphorus is mined. However, this practice is becoming ever more challenging, as the phosphorus resources of the globe are running low. A possible option to tackle the diminishing phosphorus resources would be to make the most of manure, also human waste.

A potential option to increase the use of nutrients in agriculture, and to solve the problems of sanitation, is ecological sanitation, i.e. the use of dry toilets and recycling the nutrients back to the natural cycle, which has been suggested as a way to solve the world's water and sanitation problems. Several studies (e.g. UNDP 2006, Stockholm Environmental Institute 2005) indicate that ecological sanitation would benefit the condition of ground water, and thus drinking water, soil, and human health. In this paper, ecosan refers to composted human faeces and urine diversion at source.

However, the legislation in various developed countries, e.g. the EU, does not allow the full extended use of ecological sanitation or reuse of sludge in other uses than landscaping, while the legislation in developing countries, such asZambiaorEthiopia, may be found inconclusive about the matter. Still, dry sanitation is a growing option for adequate sanitation and the projects on ecological sanitation have spread across the globe. It is, however, challenging to adopt ecosan as an option to be taken seriously. In this context, guidelines for infrastructure development, options of services and related policies do not support the dry sanitation approach or may even be contradictory. There is a niche for ecosan but its use has not been made possible in the full scale.

There is clearly a need to develop more sustainable practices. Yet, the cultural and social attitudes and practices, the taboo of human waste, and the lack of knowledge on what makes ecosan practices hygienic keep ecological sanitation from becoming a feasible option. Legislation needs to change to support sustainable practices and policies are required to guide the development of practices and attitudes.

SDWS2012.0086 Thermolysis and Gasification of Scrap Prepreg

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Abstract

With the increasing application of carbon fibre reinforced thermoset polymer composites in the aeronautical and sports industries, the waste materials, including off-cuts during manufacture and end-of-life components has reached a significant level. Current manufacturing processes produce about 30% of scrap in the form of the uncured prepreg (a carbon fibre fabric impregnated with resin). The Landfill Directive (1999/31/EC) adopted by European Union in 1999 puts a restriction on the landfilling of waste composite materials. Carbon fibre reinforced polymer composites must therefore be disposed of as chemical waste. This restriction leads to substantial disposal costs and represents a waste of valuable material.

The objectives of this paper are: 1) Study the recovery of carbon fibre, from a pre-preg type used in the aeronautical industry through a combined process of thermolysis and gasification in air atmosphere, 2) Study the influence of temperature on the process of thermolysis and gasification temperature and time, and 3) Identify the most relevant physical properties of the fibres recovered (tensile strength and elastic modulus) as a function of the variables mentioned above.

DTA-TGA was used to study the thermal decomposition of the prepreg at different temperatures, for different reaction times and in different atmospheres (N_2 and air) under isothermal and non-isothermal conditions.

The prepreg was thermolysed at different temperatures in a pilot plant, to determine the optimum temperature for the obtention of a solid residue composed of carbon fibre covered in char (a product of the depolymerisation of the resin). Thermolysis was performed at 500, 600, 700 and800ºCin the reactor's air atmosphere (i.e. in absence of inert gases). The resulting carbon fibres were examined by SEM, XPS and confocal profilometry to determine their quality/cleanliness.

The optimum temperature for the gasification of the char covering the fibres was determined in a combined thermolysis/gasification assay. After thermolysis at optimum conditions (500ºCfor 4 h), 0.2 l/min of pure air were injected into the reactor and char gasification performed at 500ºC or 550ºC for 1-3 h.

The results showed the optimum gasification conditions to be 500ºC for 1 h. Higher temperatures or longer gasification times led to smaller fibre diameters and the oxidation of the fibre surface.

SDWS2012.0214 Valorisation of Two Inorganic Industrialwastes for Manufacturing Sulfur Polymer Concretes

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Abstract

Currently, the generation and treatment of several industries are intensively studied because of they can generated an environmental problem. In this sense, taking in to account an appropriate treatment of the waste generated could lead to the production of several materials with broad applications.

In this work we have studied the stabilization/solidification in sulfur polymer concrete (SPC) of two wastes coming from both phosphate fertilizer and titanium dioxide industries, such as phosphogypsum (PG) and undissolved mud (MUD), respectively.

The usage of SPC have been recently emerged as a possible alternative as stabilizing agent for various wastes. Also, the SPC has properties, which are superior to Portland cement concrete for some applications, due to high durability and its fast setting time and rapid gain of high strength. The new sulfur polymers concrete obtained were physico-

chemically and mechanically characterized. Additionally, a leaching test has been carried out in order to evaluate the mobility of the contained pollutants in both wastes.

The main conclusion of our study was that sulphur polymer concrete let the stabilization and solidification of PG and MUD, resulting in highest strength (54-64 MPa) and low total porosity. On the other hand, the leaching study demonstrated that potential environmental impact of these new materials is very low. As final conclusion, these results indicate that the behavior of these news SPCs concretes is similar, or even better, to the SPC taken as reference currently used in the construction works.

SDWS2012.0228 Biodegradable Oil Waste as a Raw Material for Industrial Microbiology Processes

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Abstract

Industrial Microbiology is an industrial field with enormous potentials for development of eco-friendly processes for production of human wealth products, as well as products that can help cleaning of the polluted environment. Microbial production of lipases is such an industrial process. Possessing ability to make oil in water emulsions and to catalyze the lipid hydrolysis on the water/oil interface, these enzymes have unique potential applications in waste water treatment processes. What is even more important, the Industrial Microbiology processes utilize waste materials from food industry as a basic raw material for enzyme production, achieving that way multiple benefit: cheap production of enzymes applicable in waste degradation processes and prevention of the pollution.

In this work a characterization of the process for microbial production of lipases have been performed. Several wild types of microorganisms living in oil polluted environment were examined as potential lipase producers and were screened on their lypolitic activity. One microorganism showed noticeable lypolitic activity and was identified as a yeast mould Geotrichum candidum penicillatum strain. Sediment of sunflower oil, sunflower oil, olive oil, glucose, lactose, fructose and galactose were all examined as carbon sources. The yeast mould G. candidum penicillatum showed best biomass production of 11.7 g/L using olive oil as a sole carbon source, but its lypolitic activity was highest (0.26 U/mL) when using the sediment of sunflower oil as a carbon source. The yeast extract was the best nitrogen source. The microorganism grown on choused carbon and nitrogen sources,

sediment of sunflower oil and yeast extract, when used in proportion of 1:1 showed lypolitic activity of 0.28 U/mL. The morphology and the physiology of the yeast mould at different pH of the culture media were also investigated and it was concluded that the pH value has a strong effect on the biosynthetic ability of the microorganism. Initial pH 4 was the most convenient pH value for biomass production (7.8 g/L) and for lipolytic activity as well (0,316 U/mL). The youngest culture (48 hours of cultivation) used in the lowest inoculum concentration examined (5% v/v) was the most active in biomass production (13.1 g/L) and in lipase production as well (0.36 U/mL). Biomass production as high as 16 g/L and the lypolitic activity of 0.7 U/mL was achieved at the optimal reaction conditions and at mixing rate of 100 rpm. The mixture of lypolitic enzymes was extracted, purified, dried and characterized. The optimal values of temperature and pH for its activity were determined. The enzyme powder was very active at relatively high temperature of 50 ^{o} C showing activity of 4 U/mL. This enzyme characteristic is very important for its use in systems for waste water treatment.

SDWS2012.0345 Use of Bof Steel Slag in Agriculture: Column Test Evaluation of Effects on Alkaline Soils and Drainage Water

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Abstract

The use of blast furnace and steelmaking slags as fertiliser is one of the most interesting options for recycling of steel industry by-products (45.6 million of tonnes of slags produced in Europe in 2008). At present in Northern European countries slags are commonly used for liming purposes, though other positive effects for plant nutrition were observed, such as micro-nutrient supply or silicon supply etc. Slags liming potential is less interesting for neutral/alkaline, well drained soils of Mediterranean regions (such as Italy), while micro-nutrients or calcium supply could be still significant. Nevertheless, environmental concerns arise about the high content of some metals (e.g. chromium and vanadium) in the slags, especially in such soil conditions where the risk of leaching in groundwater is higher.

In this study we investigated the effects and possible risks deriving from the use of slags for amending purposes in two moderately alkaline soils by mean of a soil infiltration column test. A complete randomised design with two factors was adopted in order to

evaluate the effect of three slag doses, 0, 6 and 20 mg kg-1, on two different soils, CL (clay loam) and SaL (sandy loam). Dried and sieved soils were packed into twelve columns to a depth of 70 cm, simulating mean soil depth conditions of cropland in Italian costal plans. Sample of slags (sized 0 to 30 mm diameter) from a real steel factory were homogenised and applied in the upper 35 cm of soils. After stabilisation, deionised water was fed into the columns at a rates of 0.2 and 0.6 ml min-1 respectively for CL and SaL by a peristaltic pump. The flow was interrupted after 0.1, 0.3, 0.7, 1.2 and 1.7 liquid to solid (L/S) ratios were reached and drainage collected. After the treatment the soil columns were sectioned and analysed in the upper and the lower layers.

Risk parameters were chosen according to preliminary leaching tests performed on the slags: in drainage water and soils electric conductivity (EC), pH, metals, nitrates (NO3), chlorides (Cl), fluorides (F), and major cations (Ca, Mg, Na, K) were detected. Soils were also analysed for soil organic matter (SOM), total nitrogen, cation exchange capability (CEC), available phosphorus (POlsen) before and after the test.

Results indicated that some positive effects in terms of soil fertility has been observed: i) increased CEC and exchangeable Ca and Mg content in SaL soil; ii) a significant increase on P availability for both soils in the higher dose treatment, maybe related to the reactivity of silicates.

Risk of leaching for metals and in particular for Sb (3 to 6% of the supplied dose) are higher for SaL soil, while for the CL soil they tend to accumulate in the upper layer, as also observed for V in both soils. This could represent a limitation for a long term use of slags, because stable metals binding could be limited by the low level of SOM (< 2%) of those soil, thus further investigations on long term trials could be required.

SDWS2012.0531 An Environmental Friendly Recycling of Waste Toner Cartridges in Republic of Croatia

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Abstract

The large amount of waste toner cartridges has been generated as a consequence of it's use in printers and duplicators on the everyday basis. Waste toner cartridge contains heavy metals, plastics as well as toxic residual toner and has been characterized as

hazardous waste. Therefore the management of the waste toner cartridges presents significant issue in the environmental protection. The use of the hazardous substances in electrical and electronic equipment as well as promoting the collection, recycling and recovery targets for all types of electrical goods was prescribed by EU legislation, particularly Directive 2009/95/EC (WEEE Directive) and together with the Restriction of Hazardous Substances Directive 2002/95/EC (RoHS) has been in force since February 2003. At the moment, Republic of Croatia is in the process of becoming a full EU member so it has been obliged to implement EU legislation as well. Concerning the management of electrical and electronic equipment in Croatia according to WEEE Directive, the system has been established for the last five years but there was no practical possibility for the treatment of the collected waste toner cartridges in the country. In this work, the study of the possibility of waste toner cartridges and further recycling and reuse has been performed with the special emphasis on the reuse of the residual toner. In order to decrease explosive properties of the residual toner, the material was mixed with the calcite. After performed analyses of the mixture it was found that the mixture can not be disposed to the landfill as inert waste material since the value of the total organic carbon content (TOC) has found to be above the limit prescribed by the law. All other analyzed parameters have found to be below the limits prescribed by the law. Moreover, it was found that the mixture of residual toner which contains 10% of calcite is an excellent bitumen additive since it improved bitumen's application properties. So, the mixture of the residual toner and calcite can be used as valuable raw material in bitumen production and used in different construction works.

Environmental policy and practice

Keynote presentation

SDWS2012.0152 Preliminary Study of OREEC (Organization of Rare-Earth Exportation Countries)

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Abstract

Sustainable development is still an important issue for the world because world population grows and relating economic expands. As a result, energy consumption increases. One of a view of sustainable societies is a low carbon society, which emits carbon-dioxide (CO2) as small as possible from human activities. The largest two pillars of emitting CO2 are electricity generation and land-transportation. Therefore, nuclear power has still an important role for supplying electricity without emitting CO2. At the same time, electric vehicle (EV) and hybrid-vehicle (HV) become more important, which emit smaller amount of CO2. It becomes to be known that rare-earth elements are indispensable for manufacturing these low-carbon automobiles since these few years. However, rare-earth production is limited mostly to China because by-product of rare-earth refining process is radioactive thorium having concern of environmental hazard. In order to avoid risk in supply-chain of rare-earth materials, number of supplying country should be increased. The most important point to expand number of supplying country is to construct an international framework to protect environment from thorium. Thorium itself can be used as a nuclear fuel but it takes a few decades for its wide-use in the world due to its lack of fissionable isotope. On the other hand, amount of production of thorium as by-product of rare-earth increases every year. The author has constructed a preliminary vision of environmental friendly production of rare-earth by concerning thorium issue. It is named “OREEC: Organization of Rare-Earth Exportation Countries)”. Outline of OREEC will be presented in this paper.

SDWS2012.0287 An Integrated Product Policy (IPP) Decision Approach for the Republic of Macedonia

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Abstract

Integrated Product Policy (IPP) is an approach that seeks to reduce the life cycle environmental impacts of products from the mining of raw materials to production, distribution, use, and waste management. IPP focuses on those decision points which strongly influence the life cycle environmental impacts of products and which offer potential for improvement, notably eco-design of products, informed consumer choice, the polluter pays principle in product prices. It also promotes instruments and tools which target the whole life cycle of products.

This paper formulates an IPP framework for the Republic of Macedonia, taking into account unique circumstances faced by the country, particularly the mandatory transcription of EU environmental legislation, limited country-specific data availability and the low current level of environmental awareness. In addition, it proposes the use of Markov Decision Processes (MDPs) as a policy decision approach for IPP and demonstrates its applicability in long-term policy planning using a simple numerical example. The purpose is to evaluate what decisions (taken now and in the future) would lead to the best possible level of IPP implementation.

SDWS2012.0397 Environmental Injustice Among Flood-Affected Gypsies - Case Study on North-Hungarian Villages

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Abstract

The term Environmental Justice refers to provide all the people a liveable, healthy, sustainable built and natural environment, or at least provide to endure the same proportion of environmental risk and pollution. In fact the deprived, lower income, and ethnic people are lack of environmental justice, they must burden more of the natural and social nuisances.

The aim of this paper is to unveil the unjust situation of the flood-affected poor, including the Gypsies, in the North-East Hungary Region. The paper tries to ponder firstly, what are the consequences of the climate change in a basin-positioned country. What kind of health risks the relevant population must suffer? What sustainable solutions can be reached in water management, what are the social aspects?

More than 900 surveys were filled in 15 settlements, which were affected by the great flood of 2001 and 2010. Content analysis was made on more than 35 personal reports and written opinions about the surveyed settlements. Case studies were made on these study areas to prove the vulnerability of the mentioned groups.

The North-East Hungarian counties are the least developed in Hungary – considering socio-economic factors – and are disposing the highest Gypsy population.

North-East Hungary owing to the climate change is involved in the increasing magnitude and frequency of precipitation caused floods. Up to 2 °C temperature increase can affect more than twice as many people than nowadays in this flood region.

The Gypsy groups were settled – on purpose – on the most worthless part of the settlements, and the closest to the rivers and creeks which means greater exposure to the floods and its outcomes. After the floods, the financial and material assistance in rebuilding is discriminative. In addition the low-income people must abide the risk of getting diseased by flood-borne illnesses. The lack of sewage disposal connotes high risk of infection from faecal. Animal carcasses, carried by the flood, also give high risk-factor. The soil can keep the spores and eggs of the vectors for months after the flood. The high

humidity and poorly constructed dwellings are the seed bed for mildew, which is responsible for asthmatic morbidity.

The study is intended to represent the existing environmental injustice, and to draw attention. The most devastating fact, that the people, who are part of this process, are not aware in their deprived positions, which creates grueling struggle to reach a sustainable solution.

SDWS2012.0408 Assessment of Climate Change by Statistical Process Control Methods

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Abstract

Statistical process control (SPC) presents application of statistical methods and procedures to monitoring and control of a process in order to evaluate two sources of a process variation: natural (common) and assignable (special) causes, aiming to improve the process capability. If the variability of a process is within the range of natural causes, the process is said to be under statistical control, but when that variability exceeds the expected natural causes range it is the signal to look for and to correct assignable causes.

But can SPC be even used to "control" climate change, through comparison of today's variations with the natural variation capacity of air temperature change, precipitation or sea level change in the past? Are today's frequent floods, tornado's, warm winter periods or cold summer days actually caused by "natural" causes (meaning that they statistically should be expected), or is the natural processes "capability" changed and what view on this change is given by SPC methods, primarily invented to monitor production processes in industrial plants?

This paper will demonstrate the potentials of the use of SPC methods in evaluations of temperature and precipitation variations that should be expected, based on assessment of statistical behavior of data for these natural indicators during different periods. "Warning" and "Action" lines will be assessed and compared for the selected periods, so as number of records below or above warning and action lines will be compared, which could be useful for spatial planners, even if the causes of the changes are global or not human' induced.

SDWS2012.0062 Investigating the Impacts of Winds on SO_2 Concentrations in Bor, Serbia

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Abstract

Air pollution is one of the most important environmental problems in Bor, situated in the eastern ofSerbia. The main source of air pollution with sulphur dioxide and particulate matter is the copper smelter. The smelter operates within the RTB Bor Company (Copper Mining and Smelting Complex Bor) which producing copper for more than 100 years. The distribution of air pollutants emitted from the copper smelter, is influenced by meteorological parameters. In the present study, the relationships between daily mean concentrations of sulphur dioxide and the speed and wind direction were analyzed. The analysis includes data collected in 2011 from the four monitoring stations (Park, Jugopetrol, Institute, and Brezonik) situated in a wider town area. The Pearson correlation coefficients between SO2 and the speed and direction of winds are calculated. The correlation between SO2 and wind speed at almost all monitoring stations were negative, with one exception (Jugopetrol). This exception could be explained by the fact that winds, blowing from the NW direction, carry polluted air in the direction of this station. Moderate negative correlation found between SO2 and wind direction at monitoring station Park. This is because the monitoring locations Park and Jugopetrol are influenced by SO2 air pollution from the opposite wind directions.

SDWS2012.0318 Strategic Environmental Consideration of Nuclear Power

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Abstract

The key topics of paper are i) comparative evaluation of various energy options, and ii) radioactive waste disposal. Both are inevitable in developing nuclear energy policy. The discussion is focused on the questions Why choose nuclear technology? and Is nuclear power a good choice? while the context is uppermost level of societal energy planning,

and attempts to answer strategic questions concerned with the comparative evaluation of various energy options and radioactive waste disposal.

The key to moving towards rational energy development lies in finding the 'balance' between the environmental, economic and social goals of society and integrating them at the earliest stages of project planning, programme development and policy making. An example describing how to make such integrated consideration and comparison of different energy technologies is provided in the paper. The example has been developed based on results of a number of studies as presented in Eurelectric RESAP (Renewables Action Plan) Summary Report, and the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, both from 2011.

Related to the radioactive waste issue, the siting of a disposal facility or final repository is a task with unique traits that are clearly associated with changes in the surrounding world. A number of questions can be posed regarding how ongoing and future changes in technology, views, politics and practices in other parts of the world, concerning e.g. energy supply, nuclear power and nuclear waste, may affect national decisions regarding the approach and decisions involved in successful and safe disposal of the waste. The decision-making process has to fulfil certain democratic expectations and criteria: openness, transparency, participation. So far, known and applied approaches have not been efficient or effective in solving the primary issue of participatory decision-making in this area, i.e. proper, fair and balanced consideration of specific priorities and interests. It appears, on the other hand, that a continuous engagement process, sound and consistent, scientifically supported and respected by all involved parties, which deals adequately with uncertainties related to long-term predictions/evaluations - as applied in Finland and Sweden - can provide satisfactory results. The approach applied in Slovenia for identifying and approving a site for a low and intermediate level radioactive waste disposal facility could also be seen as being successful. In summary, the underlying basis of sucessful approach is that it is more promising to investigate which consequences of a certain alternative are more likely to be accepted by society than how likely these consequences are to occur. The paper illustrates these views by presenting and discussing long-term modelling results associated with spents fuel and low and intermediate level waste from the NPP Krsko.

Water system analysis

Keynote presentation

SDWS2012.0502 Improving National Water Management Efficiency for Sustainable Future by Technology Development in Korea

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Abstract

Korea has sustainability problem in water management. Water withdrawal rate is high as 36% and ground water level shows continuous decreasing throughout the country. Some of mid and small sized streams have been dried up for last decades. The sustainability problem may be due to rapid water use increase which has been seven folds for the last fifty year period. In addition, the sustainability problem in water management has been worsened recently by climate change.

To cope with the sustainability problem in water management, Korea needs to reduce water uses and/or improve water use efficiency. The Sustainable Water Resources Research Program (SWRRP) has been launched and conducted with about 2,000 man-year of manpower from 2001 to 2011 for this purpose. Objective of SWRRP was to develop technologies which have potential for equivalent of 10% of water uses in 2001 or improving 10% of water use efficiency in Korea.

SWRRP has developed technologies for sustainable surface/ground/alternative water resources management with institutional framework. Software and hardware tools were developed for such as water cycle simulation, climate change impacts assessment of water resources, National Water Resources Planning, river operations, hydrological observations, artificial groundwater recharge, waste water reuse, etc..

Developed technologies from SWRRP were implemented into actual water resources projects and/or test sites throughout the country. Results of these implementations were assessed to figure out equivalent amounts of new water development if these developed technologies were applied nationwide.

Nationwide potential of the developed technologies was assessed to be worth of 3.6 billion m3 of new water resources supplies annually or 14% of annual national water use of about 26 billion m3. In addition, 106 million m3 of actual annual new water supply was obtained through implementation.

The Sustainable Water Resources Research Program (2001-2011) was very effective to cope with sustainability problem of water management in Korea. Technological potential from this program was assessed to be 14% of improvement of national water uses. Especially, waste water reuse for irrigation and artificial recharge for groundwater management were quite effective for saving water and improving water use efficiency in quantity and quality.

SDWS2012.0518 Application of the New Sanitary Protection Zone Legislation in Serbia Case Study: Pancevo Water Supply System

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Abstract

Beside the fact thatSerbiastill possesses significant reserves of high quality water, the state of groundwater protection and quality is altogether inadequate. The main cause of numerous problems in this area has been the lack of adequate law regulations for years.

By bringing new law regulations in the area of determining sanitary protection zones of sources for drinking water supply from 2008, a large step was made. A good example of a quality approach to determining a sanitary protection zone for water supply is the source for water supply of the city ofPančevo. Although determining the SPZ of this source had begun before the arrival of new law regulations, this solution represents an important step forward in this area and adheres to the new regulations. Mentioned case is an example of good practice and a correct approach to solving the problem of determining sanitary protection zones of water supply sources. In the transition period, accepting new laws, example of the Pančevo groundwater source, indicates that finding the optimal solution lies in combining experience and expertise. A pure implementation of laws, without adaptation to specific situation, is almost impossible when the specificity of each individual case is kept in mind. Aim of this paper is to provide insight into problems which follow determining sanitary protection zones of water supply sources in Serbia.

SDWS2012.0478 Soil Moisture and Evapotranspiration Assessed from Remote Sensing for Sensitive Ecosystem

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Abstract

The objective of the study was to elaborate the method for the assessment of soil moisture and heat fluxes in a wetlands ecosystem, with the aim that such a method once improved or elaborated could be used in existing water balance models. The research has been carried out in the Biebrza Ramsar Convention test site situated in the N-E part of Poland. Data from optical and microwave satellite images have been analysed and also compared to the detailed soil-vegetation ground truth measurements and compared with satellite data (ENVISAT.ASAR, MERIS, ALOS.PALSAR, TERRA.ASTER, and NOAA.AVHRR). Optical images have been used for classification of wetlands vegetation habitats and for the determination of vegetation LAI. Also, heat fluxes have been calculated. Microwave images have been used to develop the method for the assessment of soil moisture. For each of the classified wetlands vegetation habitats the relationship between soil moisture and the radar signal has been examined. The results of this study make possible to improve the models of water balance over wetlands ecosystems by adding information about soil moisture and surface heat fluxes derived from satellite images. Wetlands are one of the most important ecosystems due to their biodiversity richness. The area is unique in Europe for its marshes and peat areas. Both drying and moorsh-forming (peat degradation) processes occur on a large scale mainly due to anthropogenic drainage. Controlling proper soil moisture content is essential for the protection of peat-forming plant communities and for slowing down the drying processes. Knowledge of wetlands' biophysical properties retrieved from satellite images will enable improving the monitoring of the areas. The dependence of radar backscatter on water content, due to its high dielectric constant, is crucial for wetlands examination. Radar signals have been used to differentiate between moist soil and standing water. For moisture investigations the polarisation of the microwave is very important. It was found that the difference between C-band (HH) and C band (VV) was highly sensitive to flooding. The studies show that the radar signals of different frequencies are sensitive to above-ground biomass. For obtaining biomass of wetlands the ratio of cross-polarized coefficients (HV or VH) of L- to C- bands has been shown to be well correlated with biomass. The obtained data of evapotranspiration and soil moisture may be used in water balance model for verification. A general water balance equation depends on distribution of precipitation into evapotranspiration, runoff and water storage. Calculations of water balance components are not simple, due to lack of in-situ measurements in the catchment.

The soil vegetation parameters calculated from satellite data give the possibilities to extend point measurements into large catchment.

SDWS2012.0013 Possibilities for Energy Efficiency Improvement at Municipal Wastewater Treatment Plants

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Abstract

Consumed electricity in conventional Waste Water Treatment Plants (WWTP) with active sludge technology accounts for 35 to 50 percent of the total operation and maintenance costs. The objectives of this research were to study and present the best available techniques and measures for increasing of the energy efficiency in the WWTP and particularly to present a case study for a plant in Kumanovo, R.Macedonia (91.000 PE).

This paper includes overview of the possible measures that could be used at any WWTP to increase its energy efficiency such as: use of variable speed drives (VSD), use of energy efficient motors, use of more efficient aeration systems, use of SCADA, cogeneration of electricity within the site, electricity load shifting, use of renewable energy and use of energy efficient lighting.

The research activities included: gathering information, analysis of the plant operation in the past years, identification of the largest energy consumers, presentation of the various energy efficient measures which could decrease the overall electricity consumption. Analysis was based on the plant's data base for all measured parameters compared against designed parameters. Overall energy efficiency of the plant was measured with the Specific energy consumption in regard to the BOD_5 reduction [kWh/kgBOD_5].

Existing surface aeration system with rotobrushes (Mammoth rotors) was identified as largest energy consumer in the plant accounting for 60 to 70 percent of the total energy consumption. Average monthly electricity consumption in the bioreactors, during years 2009 and 2010, was around 1,200,000 kWh per year. Therefore, most of the attention was given to increase the efficiency of the aeration system through the following measures: increasing the specific oxygen transfer rate with automatic control of the mammoth rotors operation, regulation of the fluid level in the bioreactors and regulation of the number of revolution of the mammoth rotors, use of energy efficient motors. Validation of the results

was done through simple payback period and NPV analysis for each of the proposed measures.

The proposed measures could produce annual electricity savings of almost 10 percent of the average annual electricity consumption of Kumanovo WWTP.

KW: Energy efficiency, variable speed drive, aeration system, premium efficiency motors, automatic control, surface aeration, dissolved oxygen, cogeneration, anaerobic digester, biogas, efficient lighting

SDWS2012.0080 Groundwater Balance, Natural Recharge and Drainage Zones at Open Pit Mine „Polje E“ of Kolubara Coal Basin (Republic of Serbia)

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Abstract

The Kolubara Coal Basin ranks among the largest coal basins in the Republic of Serbia.It covers an area of 600km^2 being located about 50km south east of Belgrade. The future open pit mine „Polje E“ in the Kolubara Coal Basin (Serbia) is characterised by complex geological conditions. Past explorations of the lignite deposit, where the open pit mine „Polje E“ will be opened, have confirmed spatial characteristics of present lithological members and their seepage characteristics. Observed in a vertical profile, according to the hydrogeological function of rock masses, there have been separated seven layers in the study area, three of them being aquifers: overlying, interlayer, and substratum ones. The pronounced lithological stratification in the vertical profile and uneven horizontal distribution of lithological members have resulted in pronounced spatial flow of groundwater being especially pronounced in contact zones of the overlying aquifer with the interlayer aquifer and lower with the underlying aquifer. Both interlayer and underlying aquifers are characterized by significant quantity of groundwater.

As a base for the new open pit mine protection design from groundwater, a hydrodynamic model of groundwater regime was drafted and developed as a multilayer model. Owing to complex hydrodynamic conditions in the wider area of the open pit mine „Polje E“, the model is characterized by a number of boundary conditions, among which a smaller number is determined exactly. The groundwater flow is calculated in the model and simulated as the real one, confined or unconfined, in each discretization field

individually, whereby flow conditions in the model were changed in accordance with real conditions. The model calibration was carried out in unsteady conditions, and one of results of model calibration is represented by defined and quantified recharge and drainage zones of present aquifers, as well as balance elements of groundwater in the study area.

SDWS2012.0176 Costs Analysis of the Priority Order of Water Demands from an Exergy Perspective. Application to a Spanish River

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Abstract

Water management includes some other relevant disciplines apart from water balance accounting. Sectorial demand analysis, water conservation, water rights and allocation priorities, reservoir operations, hydropower generation, pollution tracking, ecosystem requirements, and project benefit-cost analysis are all issues to be present in water analysis.

Within this framework, the proposal of this manuscript consists in testing the priority order of water demands established by the Spanish legislation. That is, if that order constitutes the energetic optimum situation or, on the contrary, it should be changed to minimize valuable energy losses. An adequate indicator to evaluate that issue could be the Environmental Cost (EC), defined in the Water Framework Directive (WFD) as the cost to reach an environmentalObjectiveStatefrom current status of water bodies. That cost can be assessed by means of Physical Hydronomics (PH), a methodology already presented in previous SDEWES Conferences. It is based on a thermodynamic property (exergy), which evaluates the available energy contained in a water flow, including its physical and chemical features.

In this sense, the alteration of the priorities of water uses could firstly imply the diminution of water discharge flows, which are retained in existing dams. Secondly, different quality returns could change the upstream river composition. And finally, depending on that priority, some uses maybe could not be guaranteed. At this point, those deficits could imply different EC assessment costs, since different technologies such as

pumping and wastewater treatment, aquifers abstraction, desalination, reutilization, or water transfers, are required to restore the quality and volume of those water deficits.

To illustrate the analysis developed here, a zoom area in theSegreRiver, a tributary of theEbroRiver(Spain), was considered. Hydrological modelling software including a reservoir, different water demands, as well as non-point contamination and returns, was characterized. Thus, this software allows evaluating different scenarios regarding to the priority of different users demands. Urban, irrigation and hydroelectric uses were considered as the key ones in the sample case. Moreover, environmental flows is not considered a water use but it is a demand whose priority is higher in the Spanish Law than irrigation of hydropower generation.

The analysis was performed for different hydrologic years in a monthly base, and also different water use priorities as well water demand volumes were established. The obtained results show very interesting consequences, in the sense of depending of those priorities and water demands, diverse environmental costs (including the energy cost of the technologies to restore the water consumed but also degraded in water uses) will be required. Therefore, these energy cost could be compared with socioeconomic cost derived from the change of the legal priority.

Biofuels and biorefineries II

Keynote presentation

SDWS2012.0272 Energy Analysis of Bioethanols Produced from Dendrocalamus Latiflorus

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Abstract

The Ma bamboo (Dendrocalamus latiflorus Munro) covers152,300 ha inTaiwan, roughly of 7.2 % the overall forest area. This study calculated the energy and mass balance of Ma bamboo as a feedstock for bioethanol production. Several processes included acidic steam explosion, alkaline steam explosion, bleached, unbleached kraft pulps, enzyme hydrolysis, and smultaneous saccharification and fermentation (SSF) for fuel ethanol production from bamboo were studied through energy consumption and energy production. Additionally, the energy use of compacting the fermented residue was also evaluated. Experimentally results show that the post-fermentation residues possessed high heating values. The net energy gains could be achieved for the processes with greater ethanol yields: acid steam explosion and fully bleached pulps. SSF could produce 220 million liters of bioethanols from by acidic steam explosion pulps and 148 million liters of bioethanols by alkaline steam explosion pretreatment pulps annually. This study demonstrated potentials of the indigenous bamboo storage as a source for bioethanol production.

SDWS2012.0434 A Citrus Waste Based Biorefinery as a Source of Renewable Energy: Technical Advances and Analysis of Engineering Challenges

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Abstract

Citrus processing waste (CPW) is one of the major wastes generated worldwide through the industrial processing of fruits for products and liquids. Over the three season's period 2008-2011, almost 10.5 million of metric tons of wet CPW, composed of peel, pulp, seeds, essential oils, and with a water content of 75-80%, were generated in the U.S.A. from orange and grapefruit juice production. These CPW materials are traditionally treated with a drying and extrusion process, and used in the formulation of a low cost cattle feed for final disposal. Environmental issues arising from the drying process include air emissions estimated in 10-20,000 tons/year of d-limonene as part of volatile organic compounds (VOCs), and emissions of CO_2 from the burning of natural gas and other fuels used in the drying process, which when combined with the lost revenue from un-recovered limonene oil estimated in 20-40 million USD/year, and the high treatment costs from the consumption of gas and electricity, have led many operators searching for more sustainable alternative methods for treatment and disposal. An alternative and more sustainable utilization of CPW could provide a renewable source of pectin-rich- and low lignin content cellulosic biomass for product conversions and biofuels.

Research on CPW as cellulosic biomass has been ongoing by USDA-ARS researchers over the last 25 years. This effort has resulted in the pilot development of one pretreatment process using water steam under high pressure and vacuum for the recovery of d-limonene as co-product, and the production of slurry of biomass containing cellulose, pectin, flavonoids and free sugars.

There has been a lack of published information for relevant scientific and engineering parameters in designing the pretreatment and enzymatic hydrolysis steps of a proposed CPW biorefinery. Data gaps exist for the impact of physico-chemical parameters such as particle size, surface area and morphology of treated- and untreated-CPW on its bioprocessing. Furthermore, there is a lack of information on relevant kinetic parameters for engineering scale up including mass and energy balances, and environmental concerns. All of these parameters are needed for reliable design, modeling, and scale up of a CPW biorefinery at both pilot and commercial scales. The objective of this paper is to

provide a review of these parameters, and its updated assessment based on preliminary laboratory scale data generated from the pretreatment and enzymatic hydrolysis of grapefruit processing waste (GPW) as a potential source for biorefinery applications. This assessment reports on the development of more reliable methods to evaluate the production of reducing sugars from pilot processes, and improved estimation of the distribution of sugars produced from several types of pretreatments including particle size reduction and caustic addition for enhanced hydrolysis.

SDWS2012.0436 Integreated Model for Eco-Sustainability of Biodiesel Production

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Abstract

Last few years biodiesel has become a hot topic, which is impressively demonstrated by the large number of LCA's published to deal with this issue [1-3]. Due to the increased pressure for sustainable development, the countries all over the world include the biodiesel production in their energy strategy documents. One of the still open questions is how to improve the biodiesel quality due to the various new raw materials and provide complete eco-sustainability.

In this work an attempt was made to develop an integrated model for eco-sustainable biodiesel production based on rapeseed and used-cooking oil raw materials. The method of Total Quality Management - TQM applied through the Green Quality Function Deployment-GQFD was used to keep the biodiesel quality as well as to design new concepts for improved fuel production. Based on the GQFD the critical biodiesel properties, their impacts and correlations were defined. Using the Life Cycle Analysis-LCA and Life Cycle Cost analysis, eco-indicators were obtained and compared for both raw-materials. Eco-it software was used to calculate the eco-indicators. Economical and social indicators were calculated also in order to provide full eco-sustainability of the production processes.

The results have shown that the quality of biodiesel depends mainly on the quality of the raw-oil material. Environmental impact was higher from the biodiesel based on rapeseed oil compared to used-cooking oil.

SDWS2012.0524 Evaluating the Energy and Carbon Sequestration from Tropical Acacias: the First Steps

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Abstract

Because of their energy content and environmental characteristics, the tropical leguminous trees are suitable for their management on energy plantations. These trees are also fast grown, nitrogen fixing, easy to establish and capable of surviving in poor quality soils. This paper presents the preliminary results of the evaluaion of the energy and carbon content and other thermochemical properties of the Acacia cochliacantha and the Acacia pennatula, two leguminous tree species of the tropical dry forest of Mexico and Central America scarcely studied in experimental fields as an energy plantations. Data were obtained from the experimental field El Colorín, at Cuentepec, Morelos, in central-south Mexico. Based on simple and multiple regression methods, allometric equations as a function of the basal area and the canopy area, were obtained to estimate the foliar, wood and total biomass of both species, 18 months after establishment in the field with correlation coefficients $R2 \geq 0.83$ in all cases On the other hand, experimental data of the heating value, the density, the humidity content, the chemical composition, and the content of heavy metals, for both species, were obtained in diferents laboratory test. The preliminary results showed that the Acacia cochliacantha and the Acacia pennatula have encouraging values of average higher heating value (HHVd) (dry base) of 18.04 MJ kg-1 and whil16.97 MJ kg-1, respectively. Finally, with this information our allometric equations were transformed into energy and carbon sequestration equations. In our next steps in our research, we will proceed to ameliorate these equations with more experimental data to try to simulate energy and carbon sequestration from these types of tropical acacias plantations. This tool will be very important to establish the economics and the sustainable management of this type of energy plantations.

SDWS2012.0122 The Benefit Evaluation for Co-Constructed and Co-Production by the First and Second Generation Ethanol Plants

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Abstract

This research will apply the domestic sugar cane, bagasse and rice straw to produce bioethanol, and with regard to the feedstock inTaiwan, we will start from the freight fare, distance and other economic factors to discuss the collect and transport logistics and the optimal location of the ethanol plant. This research will explore the potential locations and the possible amounts of ethanol plants through different scenarios. The scenarios can be divided into two categories. One is the second generation ethanol plant which is set separately, and the annual production capacity is 150 million liters. The other one is the co-construction of the first and second generation ethanol plant, and the annual capacity is 150 million liters. The transportation distance of the feedstock is limited to 50 kilometers.

This research shows that if under the condition of the second generation of rice straw ethanol plant, when the ethanol conversion rate of rice straw is 220 liters and 260 liters per metric ton, there is only one potential ethanol plant. However, as the conversion rate increases, the collection areas and the transportation distance of the feedstock can be narrowed down. If we consider the co-construction of the first and second generation ethanol plant and the feedstocks are sugar cane, bagasse and rice straw, when the cellulosic ethanol production rate is 220 liters per metric ton and 70% dual phase fallow lands can be promoted to grow sugar cane, there are two potential ethanol plants inTaiwan. If the production rate can increase to 260 liters per metric ton and all the dual phase fallow lands can be promoted to grow sugar cane, there are three potential ethanol plants. Due to the lack of potential and the narrow terrain, the eastern region ofTaiwandoesn't have the economic viability.

This research estimates what effects and changes on the production cost will happen when the cellulosic ethanol production efficiency is 220 and 260 liters per metric ton. In the former scenario, the production cost is USD 1.07~1.25 per liter and in the latter scenario, the production cost is USD 0.95~1.09 per liter. Therefore, if the cellulosic ethanol conversion efficiency can be up to 260 liters per metric ton, the ethanol production cost of the first and second generation ethanol plant co-construction can almost be the same with that of the first generation bioethanol. This research proposes that under sufficient food supply in Taiwan, the first generation ethanol sugar cane industry chain can be firstly set. When the second generation technology is mature, the first generation ethanol plants can be converted into the co-construction of the first and second

generation plant to decrease the usage of sugar cane. Then, the cellulosic feedstock can replace the food feedstock gradually and the doubt about the food supply could be erased.

Cogeneration and district heating

Keynote presentation

SDWS2012.0348 Optimal Operation of a District Heating System

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Abstract

Heat loss in pipes and pump electrical energy consumption are unavoidable during the operation of a district heating (DH) system. In order to reduce total operating costs and improve energy efficiency appropriate operating strategy should be chosen. This study is aimed at optimising the supply water temperature and mass flow rate in a DH system, depending on the heating load variations. The minimisation of operating costs of DH system with different heat sources was conducted. Two different design cases of a DH pipe network based upon of a real project redevelopment in Wales, UK, were considered. First, the DH pipe network was designed based on a low pressure loss (100 Pa/m). It means that pipes with large diameters and small size pump were chosen. Second, the DH pipe network was re-designed using a larger pressure drop (1200 Pa/m). In this case smaller diameter pipes and larger size pump were selected. An optimisation model was developed using FICOTM Xpress optimisation tool. Hydraulic and thermal calculations were validated using commercial software PSS SINCAL. Three cases with different heat sources connected to the DH network were investigated. In the first case it was assumed that the fuel cost was negligible. In the second case, water boiler was used. In the third case combined heat and power (CHP) connected to the DH network was considered. The optimisation of annual supply water temperature and mass flow rate was achieved by minimising annual operating costs. Heat loss and pump energy consumption were calculated. Results show that optimum flow and supply temperature profile over the year are different when different types of heat sources and different designs of the DH pipe network are used. The difference is particularly substantial when a CHP connected to the DH network, is used. It is observed that it is an advantage to reduce system supply temperature and increase flow rate more compared to the other heat sources connected to the DH network. In order to increase CHP electricity revenue and reduce heat loss cost when a back pressure steam turbine CHP is used.

SDWS2012.0193 Potential of ORC Systems to Retrofit CHP Plants in Wastewater Treatment Stations

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Abstract

Wastewater treatment stations take advantage of the biogas produced from sludge in anaerobic digesters to generate electricity (reciprocating gas engines) and heat (cooling water and engine exhaust gases). A fraction of this electricity is used to operate the plant while the remaining is sold to the grid. Heat is almost entirely used to support the endothermic anaerobic digestion and a minimum fraction of it is rejected to the environment at a set of fan coolers.

This generic description is applicable to on-design conditions. Nevertheless, the operating conditions of the plant present a great variation from one season to another so it is commonly found that the fraction of the heat rejected to the atmosphere is increased significantly at certain times of the year. Moreover, the heat available in the reciprocating engine exhaust gases is at a very high temperature (say 650 ºC) which is far from the temperature at which the heat is needed for the digestion (around 40 ºC in the digesters). This temperature gap offers an opportunity then to introduce an intermediate system between the engines and the digesters which makes use of a fraction of the available heat to convert it into electricity. An Organic Rankine Cycle (ORC) with and adequate fluid selection is an adequate candidate for these hot/cold temperature sources.

In this paper the effect of the addition of an Organic Rankine Cycle as intermediate system in is analyzed. On this purpose different working fluids and system layouts have been studied for a wastewater treatment station of reference and then extended to other stations configurations and locations. Optimal systems configurations have been defined from these analyses. The proposed systems yield very promising results with regard to global efficiency and electricity production.

SDWS2012.0288 Optimization of Cogeneration Power Plant Operation Coupled with Heat Storage Tank Used for District Heating of Zagreb Area, Croatia

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Abstract

Cogeneration power plant is used for simultaneous production of thermal and electrical energy which, when compared with separate production of thermal and electrical energy where large amount of waste heat is lost into the environment, results in high level of power plant efficiency and therefore helps reduce fuel consumption and greenhouse gas emissions. Implementation of the thermal storage tank to the cogeneration power plant allows separate production of thermal and electrical energy, greater thermal production capacity of the plant and increased production of electrical energy during its higher price. In this paper, using MATLAB software package, a mathematical model and optimization of a real power plant performance was made. Power plant consists of three production blocks which two of them work with gas and one with heavy oil as a fuel. The main goal of optimization was to satisfy the hourly-based variable heat demand and to maximize electricity sale profit. Calculation was made for a period of 72 hours.

Performance of the power plant with a thermal storage tank capacities from 200 MWh to 800 MWh is discussed in this paper. Presented results show that the optimum capacity of the thermal storage tank, from the power plant guidance aspect, is 670 MW and in that case the thermal storage tank is loaded mostly during the period when the electricity price is low and is discharged when the electricity price is high. For an installed thermal storage tank capacity which is less than optimal, profit from electricity sale declines.

SDWS2012.0313 Afterburning Installation of 2xST 18 Cogeneration Power Plant - Theoretical and Experimental Analysis

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Abstract

Afterburning process is used in aviation for thrust increasing at supersonic aircraft engines, placing it in cogeneration applications leading at an increased the overall efficiency of cogeneration group. The operation of the afterburning installation is affected by upstream conditions, with after effects impact on heat recovery steam generator. Design of the gas turbine – afterburning – heat recovery steam generator must consider these variables in order to insure the steam with the required parameters by the technologic process. Afterburning installation manufacturers (Eclipse Inc. - SUA, John Zink Company - SUA, Coen Company Inc. - SUA, Pillard – France, etc.) monitor their performance growth and emission reduction. In Romania, **National Research and Development Institute for Gas Turbines COMOTI –** Bucharest has preoccupations in designing and put into function cogenerative installations and up to this moment it installed two cogenerative groups of 2000 kW at SC Termica SA from Botosani, to produce both electricity and hot water for urban use. It also realized two cogenerative groups of 1750 kW with ST 18 - Pratt&Whitney gas turbine for the cogenerative power plant of Suplacu de Barcau, to produce both electricity and superheated steam necessary in the technologic process of oil extraction. **National Research and Development Institute for Gas Turbines COMOTI –** Bucharest performed theoretical and experimental researches on the afterburning installation of the 2xST 18 – Suplacu de Barcau cogeneration power plant from 2004, when it was put into function until these days. These researches aimed to integrate the afterburning installation into the cogenerative group but also to develop a performant afterburning installation, in the frame of the global tendencies of developing “smart” aggregates, that automatically take into consideration emissions, energy efficiency, electrical power quality and process requirements. The paper presents the researches performed at the afterburning installation of the Suplacu de Barcau cogeneration power plant, the theoretical and experimental results and the perspective of future development.

SDWS2012.0070 Optimization of Binary Co-Generative Thermal Power Plants with SOFC on Solid Fuel

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Abstract

Tendency of the World Energetic is designing high performance power plant and application of alternative technologies, in order to significantly reduce fuel consumption and meeting environmental and economic criteria. For this purpose the paper is treating the problem of binary co-generative power plants with high temperature solid oxide fuel cells (SOFC) on solid fuel with a high power, that belong in to the group of highly efficient power plant. Main emphasis is placed on coal (lignite gasification), fuel applied not only in Macedonia but in the world.

For optimization and calculation of this type of plants programming package is made, consisting of a number of programs and subprograms. A complex function of many variables has been optimized, and the criterion of the optimization is maximum efficiency. Based on previous optimization performed a calculation was made of the characteristic values of this plant: the basic dimensions, the required number of modules, electrical power and fuel cell efficiency, electrical power and efficiency of the gas turbine plant, electrical and thermal power of the co-generative steam turbine plant. The programming package is flexible and has the ability to display a number of sizes (results) in all characteristic points, environmental and economic calculation. Also a calculation has been made that refers to a plant in different variants, and basic input size is the power of fuel cell.

For verification of the program package a comparison of the results obtained from the program package is done with practical already performing plants and with analyzed results from similar plants from reputable manufacturers. Also, there is a comparison of the binary cogeneration power plant with SOFC fuel cell and cogeneration plant without fuel cell, in relation to efficiency and environmental benefits.

Thus conceived power plant composed of fuel cells, gas turbine and steam turbine cogeneration plant is characterized by a threefold production of electricity and production of heat is getting high and reaches 70% efficiency, as well as significant environmental benefits. The only drawback is still the high cost of fuel cells, which are expected in the near future to become a competitive market.

SDWS2012.602 Analysis of More Efficient and Sustainable Future District Heating Networks

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Abstract

In this paper use of plate heat exchanger in the municipal district heating for the development of more sustainable hot water supply systems is analysed. To reduce the cost of coolant and the cost of its transportation a two-stage mixed scheme has been proposed, allowing the use of warm return water heating system to preheat the cold water source. Moreover, to make solution more sustainable, effective selection of heat exchanger in the same scheme could utilize low temperature sources such as geothermal, solar or waste heat. Two-stage hot water circuits are more expensive and its value relative to the parallel circuit is 2-2.5 times higher, depending on the ratio of heating and hot water loads. Application of two-stage scheme allows for the same load of hot water to save up to 30% of the carrier relative to its consumption for the conventional parallel scheme. So the benefits from getting higher efficiencies and lower operation costs must be weighed against the higher costs of installations. Effectiveness and reliability of the proposing method is demonstrated on the real heat point calculation while the possibilities for installation in combination with renewable low heat sources are analysed for Ukraine, Croatia and Hungary. The sustainability of solution is reflected trough economical, environmental and evaluation of security of supply.

Sustainability comparisons and measurements methodologies

Keynote presentation

SDWS2012.0079 Environmental Impact of Soil Remediation Activities: Evaluation of Quantitative and Qualitative Tools.

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Abstract

When evaluating remediation technologies for contaminated soil and groundwater, the beneficial effect of the remediation, namely cleaner soil and groundwater, are mostly emphasized without consideration of the environmental impact of the remediation activities themselves. Nevertheless, different qualitative, semi-quantitative and quantitative methods to estimate the environmental impact of soil remediation activities are available. Within the framework of contaminated site management, an environmental impact assessment can be performed for two main reasons: to guide a user in his choice for a potential (future) soil remediation technique, or to evaluate the environmental performance a soil remediation technology after the remediation has been carried out. In the present study, different tools which can be used to estimate or quantify the environmental impact of a soil remediation process were critically evaluated. Therefore, 3 case studies were worked out, in which several remediation options were evaluated for each case, based on data of the soil remediation project itself or on data from pilot projects. The evaluation tools that were used consisted of a BATNEEC (Best available Technique not Entailing Excessive costs) analysis, different types of CO_2 calculators and two more detailed LCA (life cycle analysis)-based evaluation methods.

A life cycle management (LCM) approach structuring environmental activities, combined with life cycle analysis (LCA) for a quantitative examination, can be helpful for the selection of site remediation options with minimum impact on the ecosystem, human health and the environment in general. However, LCA-based evaluation methods are rather complex and require much more data than a classical BATNEEC analysis or the calculation of the carbon footprint. The case studies worked out in this papers highlight the most important parameters to take into account for the evaluation of the environmental footprint of soil remediation activities and provide a guidance for environmental impact assessment within the framework of contaminated site management.

SDWS2012.0303 Defining Sustainability Indicators of Iron and Steel Production

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Abstract

Iron and steel production are important industrial processes as iron is the least expensive and most widely used metal in society. The growth rate of annual global steel production has increased more than double compared to 1970. Increased production rates of iron and steel promote economic wealth on one side, however on the other side they impose challenges to sustainable development due to emissions associated with iron and steelmaking, managing of waste, use of resources and land degradation from mining. This work assesses the indicators and parameters that are important to define the role of iron and steelmaking operations to sustainable development and reviews the major environmental challenges that need to be addressed by the science, industry and policy. Two major ironmaking technologies based on blast oxygen furnace and electric arc furnace are comparatively assessed in this work. The sustainability indicators used for assessment consist of the economical parameters, greenhouse gas emissions, freshwater consumption, land use requirements and pollution to air and water from two ironmaking technologies. These parameters are then compared to the performance indicators from the other two fundamental societal essentials, those of energy generation and food production.

SDWS2012.0430 Analysis of the Sustainability Reporting Initiatives of Electric Utilities in Brazil

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Abstract

Several companies worldwide began, in the last two decades, to voluntarily publish corporate sustainability reports (CSR). This voluntary reporting activity includes social and environmental disclosures in their annual reports, or in specific companies' publications. One can argue that this fact is a way for companies to manage their reputation and image in order to establish or maintain organizational legitimacy. Several of these companies have chosen the Global Reporting Initiative (GRI) guidelines as a

model for sustainability reporting. These guidelines suggest that the report should present the organization's performance in a broader context of sustainability, that is, evaluating and reporting the company's performance within the limits and demands of environmental or social resources at local, regional or global levels. In Brazil, the use of GRI guidelines is particularly common practice in the electricity sector. In this context,the objective of this paper is to present the first findings of an ongoing research about how the main electricity utilities in Brazil report their sustainable practices. Therefore, we evaluate whether the tools used are able to provide the stakeholders with sufficient information to draw a profile of the company's sustainable performance and to ensure a full and transparent reporting of these companies' practices on the path towards sustainability. In addition, assessed how the GRI guidelines are being used by these electricity distributors. To do so, we carried out a comparative study of the sustainability reports of the electricity distributors in Brazil. We analyzed and compared the indicators and methodologies that companies use in those reports, in order to verify the presence of a pattern in the manner in which the distributors use the guidelines and its indicators. We also also checked if the reports follow the concept of sustainability that the GRI proposes, and if the guidelines are a good model for Brazilian electricity distribution companies. Our first findings show that as the GRI guidelines are voluntary and do not require external verification, there are significant differences in how the distributors use the guidelines, specially differences in the number of indicators and in the quality of the information reported. It is interesting to observe that the concepts of sustainability that those companies adopt are frequently different of what GRI proposes.

SDWS2012.0182 Methodology for Sustainability Assessment and Resource Efficiency in Forest Sector

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Abstract

The use of natural resources, as well as land use or utilization of other ecosystem services, should be based on an evaluation of carrying capacity of the system, and should be designed taking into account social, economic and environmental dimensions, with an integrated assessment of renewable energy. Therefore, the methodology to evaluate the Carrying Capacity presented below will be a part of a Decision Support System, which will include indicators about environmental impacts, technology assessment of machineries, economic dimension, and social aspects. The methodology developed for the site-specific assessment of the biomass availability, with respect to carrying capacity,

consists of quantification and mapping (using Geographic Information Systems) of forest biomass taking into account local features (e.g. abundance, spatial distribution and type of species) as reported in local territorial plans. The quantitative results, which represent three different "availability levels" of biomass are: the Theoretical Potential, the Technical Potential, and the Net Energy Potential. The Theoretical Potential is defined as the biomass that can be harvested annually without affecting the resource and as it is stated by local planning. the Technical Potential is obtained by subtracting firstly the Current Uses of wood from the Theoretical Potential. Then, the Technical Losses are subtracted in order to obtain the Technical Potential. It represents the estimated biomass available for the energy use. Final aim of the proposed methodology is to assess the feasibility of short supply chains forest-wood-energy, so the ultimate goal should be to obtain a potential value in terms of energy: the Net Energy Potential. The methodology is applied to two mountain areas of Como Province: Comunità Montana Lario Intelvese (CMLI) and Comunità Montana Triangolo Lariano (CMTL). Results are distribution and availability of forest biomass. In terms of Replacement of fossil fuel, main results for the two case studies are 2138 toe/y for the CMLI area and 2351 toe/ for the CMTL area. Policy of the Province of Como identifies small chips plants (power below 1 MWt) as optimal solution in order to use the resource in energetic valorisation. A thermal power plant using forest chips for district heating is located in the CMLI area, it has a power of 240 kWt and it supplies heat to a pool. Considering the consumption of this facility and the biomass availability calculated, it is estimated that each study area can be provided with 20 similar plants. The proposed methodology evaluates the possibility that forests can provide the supply of raw material for energy production among ecosystem services. In addition, this assessment aims to integrate considerations to protect the other ecosystem services. Moreover, the proposed methodology is useful for a preliminary assessment of the possibility to considering woody biomass in energy planning at local level.

SDWS2012.0594 Organizational Attention Deficit as Sustanability Indicator: Assessment and Management

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Abstract

In today's knowledge based economy (society) attention is a vital component of mental capacities. However, the current indicators of sustainable development (ISD) are accountable for material and energy resources and their impacts, without concerns on mental resources and capacities. The aim of this paper is to contribute towards filling this

gap by analyzing the attention indicator in a standard Pressure-State-Response (PSR) framework.

Hence, the daily information overflow is identified as a pressure variable adversely affecting the attention. This is manifested by an increased likelihood of missing key information when making decisions, diminished time for attentive reflection, difficulty in holding others' attention, as well as by decreased ability to focus when necessary, which are symptoms of the socalled organizational attention deficit disorder - OADD.

As to the state variable we combine techniques from cognitive neuroscience and applied sciences in order to objectively measure the incidence of OADD. In particular, the use of neuropsychological and neurophysiological procedures for objective assessment of OADD will be summarized. Firstly, few attention diagnostic tests of the Amsterdam Neuropsychological Tasks Program (ANT) will be considered for determining the focused, shifted and sustained attention. ANT is a battery of neuropsychological tests that allows systematic evaluation of information processing capacities. Measured and analyzed parameters are speed, speed variability and accuracy of performance. We also measure a social adaptability by applying the ANT tasks for identification of facial emotions as well as face recognition. Furthermore, the characteristic neurophysiological findings in OADD will be presented in more detail including quantitative electroencephalography (QEEG) power spectra brain maps and additional brain-rate parameter.

As intervention measure attention strengthening techniques are to be applied. In particular, we have proposed the neurofeedback technique as response variable and have shown its effectiveness in coping with the OADD.

This approach represents a new perspective in social psychophysiology and expands the potential applications of ANT, QEEG and neurofeedback methodology. Simultaneously, it opens a new theme within the social dimension of sustainable development.

SDWS2012.0316 Evaluating Sustainability in the Flemish Dwelling Construction Sector

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Abstract

Reducing the ecological impact of housing is receiving increasing attention by researchers, policy-makers and industry. As a result of the EPBD 2010/31/EU (EPBD, 2010), the focus in Europe is primarily on reducing energy consumption. To generate a more complete picture of the environmental burdens and avoid problem-shifting, it is appropriate to work within a life cycle perspective. Different techniques like Life Cycle Assessment (LCA) exist and are often used to evaluate independent case studies, but until now it has never been used to as evaluation tool on a bigger scale.

This study describes the start-up and methodology of a project to evaluate the sustainability of the Flemish housing industry. The main goal is to evaluate the common building practice and methods of contractors and building promoters and link this to a financial feasibility analysis. Both ecological and financial aspects will be examined, using techniques of LCA and Life Cycle Costing (LCC). Of course this will not be an endpoint, but the results will be used to develop improvement strategies. The results of this project can be a basis for policy-making.

Energy efficiency; in industry and mining, appliances

Keynote presentation

SDWS2012.0183 Improvement of the Energy Use and Comfort Conditions in Offices by Real-Time Feedback Actuations. Living-Lab Testing.

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Abstract

Nowadays, energy efficiency goes beyond technological aspects, involving social actions and people sensibilization. Proven feedback techniques combined with price policies and based on reliable measuring at home have demonstrated the feasibility of cutting down consumption up to 25% while maintaining high levels of comfort [1]. Besides, it is well-known that productivity at work bears a close relationship to the work environment and to the comfort status [2].

A system for providing real-time feedback implemented in a computer by pop-ups messages and sensibilization information in offices was developed and validated in laboratory. The system integrates the previously identified key aspects for energy consumption reduction and the comfort criteria for lighting and climatization. For feeding feedback application, measurements of thermal and lighting environment conditions and energy consumptions were integrated in a system connected to worker computer.

Before releasing in a real-office, it was tested in IBV living-lab. Eight users used to work in offices simulated common office tasks: reading, computer tasks and filing in two scenarios: WITH and WITHOUT receiving feedback from the measurement system. Tests were performed in the context of a general ergonomics assessment to minimize laboratory effect. All tests were in summer time and users were able to choose thermal and lighting conditions at any time. To detect any reduction in comfort, objective (skin temperatures) and subjective (thermal comfort survey) information were collected during the tests.

Average temperature setting (cooling) in case of having feedback was 1,5ºC higher with subsequent energy savings. Regarding thermal comfort, no difference in objective measurements but a slight improvement in thermal perception was found in case of having feedback, as some people reported feeling “Cool” in case of no feedback and more

users referred thermoneutrality with feedback. In lighting, reduction was about 50% without a reduction of comfort.

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SDWS2012.0053 The Impact of Smart Metering to Energy Efficiency in Low-Income Housing in Mediterranean

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Abstract

Between 1990 and 2007 the household final energy consumption in European Union (EU) increased by 8,0% at an annual average rate of 0,5%. Space heating and cooling remains the most significant component of household energy consumption but the demand for the electricity from appliances has increased most rapidly. Comparison between the EU's 2020 energy efficiency targets and the forecasted energy saving according to the National Energy Efficiency Action Plans (NEEAPs) of Mediterranean countries clearly indicates a gap in the residential sector. One of the reasons lies in low-income housing, which represents 30 to 40% of Mediterranean households. Low-income refers to households which usually do not have sufficient resources to have an easy access to credit or capital in order to invest in energy efficiency, and need innovative policies instruments to deal with the energy efficiency.

Smart metering is a technology where end-use energy efficiency can particularly be encouraged through its impact on tenants' behavior. Smart meters can give consumers clear and comprehensive information about their energy consumption and can help them become more energy efficient. Improved energy end-use efficiency through the affordable smart metering applications in household sector should make it possible to exploit potential cost-effective energy savings in an economically effective way. Estimations show that smart electricity grids developed under current EU legislation should reduce the annual household energy consumption by 10%.

Within this paper it has been evaluated how consumers in low-income housing can respond to energy prices through demand-response and reach expected 10% energy savings on electricity consumption. Consumption feedback provides an independent and

customizable means to offer consumers a more direct, comparable and comprehensive information about their household's energy consumption pattern. Potential and possible positive impact on the energy consumption of the multi-energy consumption feedback in low-income housing is also discussed in the paper.

Activities presented in this paper have been evaluated within the EU project called ELIH-Med. Objective of the ELIH-Med project is to identify and conduct a large scale experimentation of cost effective solutions and innovative public and private financing mechanisms backed with Structural Funds to foster energy efficiency investment in low income housings or household in a state of energy poverty.

SDWS2012.0072 Development of a New Gas Screw Compressors Family,with High Delivery Pressure (up to 45 bar)

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Abstract

Due to the advantages it presents, screw compressors, which are part of positive displacement compressors, can find an increasing use in gas industry and beyond. In Romania, INCDT-COMOTI is the only company that designs, manufactures, experiments, supplies, provides technical assistance and spare parts for two types of compressors: centrifugal compressors and screw compressors with oil injection. Initially, the compression units were fully acquired from GHH-Rand Company-Germany, INCDT-COMOTI making compression equipment (package). Over time, the confidence gained from the German partner, made that in a relatively short period to be assimilated license for manufacturing screw compressors with oil injection in the range CU (licensed in April 2010). But maximal parameters of these licensed devices stop at a maximum flow of 3000 Nm3/hour and 26 bara discharge pressure. Requests / signals from potential beneficiaries, both in country and abroad, have imposed the necessity of design and manufacturing of a new family of screw compressors with oil injection, able to develop discharge pressure of 45 bar, flow rates between 1000 and 5000 Nm3/hour. The paper presents the achievements of the INCDT-COMOTI-design, manufacturing, testing, test stand –for the family of screw compressor with discharge pressure up to 45 bara type CU 90 HP and CHP 220. Continue research and development have allowed that, this type of screw-compressor- to find a market position, diversifying its size range in the last decade in a

manner more explosive, if we refer to other types of the compressors (centrifugals and reciprocatings).

SDWS2012.0501 Techniques for Establishing and Maintaining Constant Temperature in ICT Systems in Order to Reduce Energy Consumption

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Abstract

Temperature is an important parameter in the operation of computer systems, industrial and research, maintaining it between certain values to ensure their proper functioning beeing important. Computer systems are designed to work best when the ambient temperature is in the range 20 – 23°C. This requirement working arrangements to ensure the equipment rooms with complex automated systems on control and ventilation equipment to maintain the temperature around the components specified, regardless of variation amount of heat released by them in operation and regardless of external temperature variations.

To maintain the required temperature values are needed energy consuming equipment. To keep power consumption constant temperature is required to be maintained in an area as small limits based on the regular registration of consumption variation depending on environmental factors.

In this paper presents a virtual device used to alert the user if there are changes in system operating parameters, changes that could result in damage to the ear if not take immediate remedial measures. This device it will be applied to improve functioning of network infrastructure, Grid site RO-14-ITIM and MPI Clusters located in datacenter from our Institute.

Acknowledgement

Financial assistance provided through the Ministry of Education and Research of Romania (Human Resources program: project TE 76 / 2011; EU12/2009) is gratefully.

SDWS2012.0028 Potential for CO_2 Emission Reduction in the Cement Industry

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Abstract

The cement industry is one of the largest carbon emitting industrial sectors in EU and in the world. It accounts approximately for 4.1% of EU's, and around 5% of world's anthropogenic CO_2 emissions. In line with the EU commitment to combat climate change, cement industry, as the third largest carbon emitting industrial sector, needs a more sustainable future. Following the importance of the cement industry in Macedonia, a candidate country for EU membership, the present work analyses the potential of CO_2 emission reduction in Macedonian cement industry. The main processes contributing to almost 90% of CO_2 emitted from the cement manufacturing are the calcination and the combustion of fossil fuels. The calcination process, which contributes to around 50% of CO_2 emissions, is the thermal decomposition of limestone into lime, needed for the production of clinker. Combustion of fossil fuels contributes to around 40% of CO_2 emissions, and the remaining 10% comes from the transport of raw material and some other production activities. There are several effective measures, which can be applied in cement manufacturing processes to achieve emissions reduction targets. Simultaneously these measures can reduce the local environmental impacts and improve the competitiveness of the cement industry. One of the most effective ways is to capture CO_2 from the flue gases and store it. This can reduce carbon emissions by as much as 65–70%, but till now there are no industrial scale carbon capture and storage technologies available. By reducing clinker to cement ratio with the addition of various additives, CO_2 emissions can be reduced substantially. Improving the energy efficiency of the clinker production process is also one of the possibilities of CO_2 emissions reduction. However, it was found that the substituting fossil fuels with alternative fuels may play a major role in the reduction of CO_2 emissions. All these measures have been analyzed in Macedonian conditions, and a set of priority actions has been derived based on their environmental and economic effectiveness.

SDWS2012.0598 Investigation of Energy Efficiency Potentials of the Macedonian Pig Sector and Their Practical Implementation's

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Abstract

Macedonian swine production sector is vital part of overall agricultural sectors in the country. The applied technology of production over the state is generally separated in two concepts - "large industrial" and "medium to small" family farms. Applied technology makes this sector a significant energy consumer. The issues related with “energy saves” and “energy efficiency” in Macedonian pig husbandry are neglected historically. Energy efficiency of Macedonian pig farms was not a subject of proper analysis and investigations. Other nations experiences about "on farm" energy efficiency shows that farm energy savings may significantly reduce costs of the production. The objective of this investigation was exploring the potential for energy saving in pig husbandry in theRepublicof Macedonia and the possibilities for their practical implementation.

Based on applied research methods (Stakeholders analyze, SWOT, Problem tree & Objective tree), we conclude that in our country the majority part of small and medium pig farms are construct with very low standards related to energy efficiency and we also assume that the farmers are “heating” their animals with “additional feed”. According to this founding's we create the bio-economical scenario and develop the Model for possible energy losses via “additional pig feed”. The idea was estimation of the energy losses due to the urgent animal needs in higher daily feed intake under the lower room temperatures. The results show that such scenario of production leads into direct and indirect increasing of costs due to not appropriate thermo isolation of the farms. In addition to this model, we developed "pig farms energy efficacy calculator". The main objective of this tool is to improve public awareness about energy efficiency and proper energy planning in national pig sector. Having in mind the latest world prices of feed - energy from animal feed the present farmers habits looks like very inappropriate concept of heating of pig farms. From the sustainable development aspects, energy efficient on the pig farms ofRepublicofMacedoniawill contribute in proper development of the rural communities, decreasing of migration of population, reducing pollution and improvement of farm economics.

Waste management

Keynote presentation

SDWS2012.0201 Environmental Performance of the Municipal Solid Waste Collection System for Sustainable Services in Urban Areas

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Abstract

Cities have grown in population and expanded geographically enhancing new buildings developments and infrastructure necessities. This vertiginous evolution provokes a high level of direct and indirect environmental impacts associated to the building industry and use such as the urban waste generation. Actually, in Spain 25% of urbanized surface was developed within the 20th century last decade which carried out a municipal solid waste generation of 547 kg/inhabitant in 2009, even higher than EU-27 the average of 513 kg/inhabitant.

Sustainable transportation infrastructure and travel policies have the objective to optimize the use of transportation systems to achieve economic and related social and environmental goals. To this end, a novel methodology based on life cycle assessment has been developed in this study with the aim of quantifying in terms of equivalent CO_2 emissions the impact associated with different alternatives of waste collection systems in different urban typologies. This new approach is focused on enhancing the energy and raw materials saving and reducing the environmental impacts associated to waste collection system in urban areas as well as allowing the design and planning of the best available technologies and most environmental friendly management. The methodology considers a large variety of variables from the point of view of sustainable urban transport such as the location and size of the urban area, the amount of solid waste generated, the level of social awareness on waste separation procedures, the distance between houses and waste collection points and the distance from these last to the possible recovery plants and/or landfills taking into account the material and energy recovery ratio within an integrated waste management system.

As a case study, two different waste collection systems have been evaluated with this methodology in the Ecocity Valdespartera located in Zaragoza/Spain and consists of approximately 10000 homes: (i) a system based on traditional truck transportation and manual collection, and (ii) a pneumatic collection system. Results allow recognizing the most efficient and sustainable alternative to be implemented in the location, establishing scientific criteria for the design and planning of eco-cities and, in general, promoting integration and use of good practices in several processes and urban infrastructures.

SDWS2012.0418 Analyses of Environmental Impacts of non Hazardous Regional Landfills in Macedonia

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Abstract

Purpose – The purpose of this paper is to present the environmental impacts on the water environment caused by the planned nonhazardous regional landfills in Macedonia. The state waste management strategy is based on regional municipal waste management system. Treatment and final disposal of municipal solid waste is planned on regional landfills. This study presents possible environmental impacts caused by municipal landfills leachate, it shows estimated leachate quantities and also technical measures for elimination or mitigation of possible environmental impacts.

Design/methodology/approach – Starting from the geographical distribution of waste generation, applying basic principle to cover a territory with more than 200.000 habitants, 8 waste management regions were considered. Suitable potential landfill locations are selected, waste quantities and landfill capacities are estimated. Estimation of the leachate generation rates within the landfill is performed by the Water Balance Method using climatic and meteorological data of the nearest meteorological stations, as well as parameters from the practical exploitation of nonhazardous landfills in developed countries.

Findings –Results of this study identify possible environmental impacts on the water environment. Considering leachate quantity and complexity and temporally variability of the leachate composition, technical alternatives for leachate treatment are proposed for each waste management region.

Originality/value – The analyses give a view of possible environmental impacts caused by the landfill leachate from regional landfills inMacedonia. It is a unique work, since no analyses about leachate quantities have been carried out on a country level. The paper also provides data on which further research could be carried out, especially about measures for elimination or mitigation of negative environmental impacts.

SDWS2012.0377 Thermogravimetry as a Research Method in the Transformation Processes of Waste Rubber and Plastic Products for Energy Carriers (WTE and WTL Processes).

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Abstract

Processes WtE and WtL are a range of future technological processes, designed for highly efficient processing of waste, including waste tires and waste plastic, directly to the carriers of energy (WtE processes) or on the components of liquid alternative fuels (WtL processes). These processes, in addition to the importance of energy, have a positive impact on the environment. In addition, the processing of waste substances shall be zero carbon dioxide emissions for the estimation of LCA in the technological.

Determination of optimal technological conditions of WtL and WtE processes, including environmental requirements, requires the recognition kinetics of thermal decomposition of waste materials and to identify the chemical composition of decomposition products in real time. Whether it is important to also assess the temperature of phase transformations occurring in these processes and the nature of change in terms of thermodynamic.

Thermogravimetric studies, performed using modern analytical equipment allow to determine the conditions and the identification of thermodynamic transformations, and also to investigate thermal decomposition kinetics of selected groups of waste.

The article presents research results and their interpretation in the analysis of thermal decomposition processes of selected materials from waste tires and plastics to a preliminary estimate of the optimal conditions processes WtE and WtL. The presented results include the thermal decomposition of mixtures of waste rubber and plastic products in different proportions. The article estimated the possibility of using the energy of these mixtures in a single technological system, taking into account environmental requirements.

SDWS2012.0578 Terrestrial and Underwater Pollution Monitoring Using High-Resolution Electromagnetic Sensors

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Abstract

Land, marine, coastal, river and lake pollution present a serious problem affecting human health, biodiversity, tourism, fishery, cultural heritage and other environmental issues. Moreover, there is very little and often inconsistent information on quantities of litter in terrestrial and underwater environments. In many countries there is also a lack of efficient technical tools for detection and classification of waste by nature and origin. The main objective of this paper is to study the potential use of high-resolution electromagnetic (EM) sensors to monitor environmental pollution in land and water.

Since different environmental conditions demand different sensor types, we performed a theoretical analysis and proposed a multisensory system composed of various non-destructive and non-invasive EM sensors at different frequencies. Low frequency sensors are based on ultrasonic sounding and electromagnetic induction (EMI) approach, whereas high frequency sensors are based on the ground penetrating radar (GPR). An ultrasonic approach is capable of long-range waste detection. We present a complex sensory system design, where the multisensory system on robotic platform moves closer to a suspicious object to accurately identify the object by using the EMI sensor and GPR. The EMI sensor is able to detect metallic objects, such as metal waste, mine, mine like-targets and metal objects with historical value including non-magnetic metals, whereas the GPR observes radar wave reflections at the interface boundaries where the dielectric permittivity changes. Thus, GPR can detect both, metallic and non-metallic objects.

We tested components of the designed multisensory system and found that it has the capacity to discover, map and interpret waste from various materials in different environmental conditions with the option of the objects' size and shape reconstruction as well as waste classification and its quantity estimation. The results of this study offer new possibilities to improve the understanding of the current status of the terrestrial and underwater pollution problem.

SDWS2012.0515 Pyrolysis of Municipal Solid Wastes in Thermogravimetric Analyzer

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Abstract

Due to the great increase of the world population, wastes arise from the human activities emerge as a global environmental issue. Since production and accumulation of household wastes cannot be prevented, disposal of these wastes in an economical way is of growing importance. Pyrolysis, the thermal decomposition of materials in the absence of the air, represents a suitable way of utilizing waste materials by converting them into liquid fuels and chemical feedstocks.

For the accurate and sensitive modeling, design, scale-up and operation of the pyrolysis processes, it is necessary to enlighten the thermolytic behavior of the pyrolyzed materials. Thermal decomposition of materials primarily depends on chemical composition and structure of precursor. The degree of crystallinity and polymerization of the starting materials are integral in defining their respective thermal degradation behavior [1]. Since precursors used in pyrolysis are usually heterogeneous in terms of chemical composition, kinetic identification of the process is more complex.

Thermogravimetric analysis (TGA) is one of the most common techniques used to investigate thermal events and kinetics during pyrolysis [2]. Due to sensitivity and simplicity in gathering the mass loss data, kinetic studies with TGA has gained wide acceptance. In this technique, the change of a sample mass is monitored against time or temperature in the absence of oxygen at a specific heating rate [3].

The purpose of this work is to investigate and broaden the understanding of the pyrolysis of household wastes by a thermogravimetry. Based on the outcomes, a plausible kinetics for pyrolysis of two different household waste, used coffee and tea wastes, is reported.

SDWS2012.0514 TGA Pyrolysis of Carbonaceous Materials

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Abstract

Both the growing awareness of the decreasing availability of fossil fuels and the increasing pressure on the environment from production and combustion of fossil fuels, have nowadays led to a deeper interest in sustainable heat and power generation using biomass [1]. Besides, a considerable attention has been focused on disposal of waste tires and plastic for recovering the high energy contents of these non-biodegradable wastes. At this point, co-processing of biomass, waste tires and plastics with the fossil fuels such as lignite and oil shales by pyrolysis process seems a promising method to both energy recovery and environmental protection.

Pyrolysis is a thermochemical process that converts organic materials into usable fuels. During pyrolysis, successive reactions like cracking, isomerization, dehydrogenation, aromatization, and coking occurs [2]. For the improvement and scaling-up of the pyrolysis processes, there is a need to understand the basic kinetics of these complex reactions. By thermogravimetric analysis (TGA) it is possible to study the pyrolytic behaviors of carbonaceous materials by allowing to follow the process in a controlled manner. Also this technique is a rapid, inexpensive and simple to clarify the overall kinetics.

In an attempt to fulfill the requirement of determination to the pyrolysis kinetics of carbonaceous materials, in this study, thermal decompositions of lignite, oil shale, waste tire, plastic (PET) and biomass samples are investigated by using TGA. The experiments were conducted under N2 atmosphere with a heating rate of 10K/min. from room temperature to 1273 K. After pyrolysis process, kinetic parameters were derived and thermal decomposition ranges were determined through the TGA results.

Cooperation and development/Technology transfer

Keynote presentation

SDWS2012.0167 Improving Capacity of Jordanian Research in Integrated Renewable Energy and Water Supply – JoRIEW Project

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Abstract

Sustainability and sustainable development of energy, water and environment systems are the ultimate goals of the societies that care about their own future. To reach these goals it will not be enough to apply new technologies and process but it will seek for a wider approach to the integrated system planning and to large scale cooperation between different stakeholders. The knowledge transfer is one of the important pillars of transforming the current system to the more sustainable one. The paper describes results of networking achieved within recently started JoRIEW project that will have significant impact on Jordanian national policy in terms of water management, renewable energy sources and energy saving. The objective of the JoRIEW project is to reinforce the cooperation capacities of Jordanian research centres by promoting closer scientific collaboration with a number of European located research centres and universities. The project will help to structure and enhance S&T cooperation in areas of common interest, such us system integration, integrated energy and water planning, development of water supply systems that can be powered by intermittent renewable energies, in particular flexible pumping techniques and reverse osmosis desalination technology, where joint research efforts could bring common solutions and mutual benefits. Improving Jordanian capacities in research will be achieved through following activities that are in detailed presented in the paper: Networking of Jordanian and EU research centres in view of disseminating scientific information, identifying partners and setting up joint research Developing training modules to build competency and facilitate the Jordanian participation in FP7 projects regarding energy and water research Developing the Jordanian research strategy for sustainable and renewable energy and water desalination in order to increase its scope, in particular its regional coverage and to improve its responses to the socio-economic needs of Jordan and other countries in the region

SDWS2012.0133 Development of Green Chemistry Processes for Production of Eco-Friendly Compounds from Renewable Resources

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Abstract

Green Chemistry is an environmentally benign chemistry and it refers to a design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. It is characterized with: minimal waste production, minimal energy consumption, efficient raw material use such as that of renewable resources. Prevention of pollution instead of cleaning the already damaged environment is the paradigm of the Green Chemistry processes.

In this work a development of such processes for production of eco-friendly biosurfactants from renewable agricultural resources has been performed. Agricultural waste, such as that of crops and oil crops production waste, were used as raw materials. Specially created enzymes, lipases and glycosidases, from wild types of microorganisms as well as from genetically modified microbial strains and one glycosidase from plant origin were used as catalysts for the biosurfactant synthesis.

Those enzymes belonged to the group of hydrolases, but instead of its natural function, the hydrolysis, they were used to catalyze the reversed hydrolysis and the transferase type of reactions. The effects of the relevant reaction conditions on the enzyme activity and the product yield were all investigated. The enzyme selectivity (r_S/r_H) was a parameter of crucial importance in the transglycosylation processes and it was thoroughly investigated, as well. Several commercial enzymes such as the Candida rugosa lipase, Rhizomucor miehei lipase, Humicola lanuginosa lipase, the fungal Aspergillus oryzae glycosidase, the yeast Kluyveromyces marxianus glycosidase, the bacterial Escherichia coli glycosidase, the almond β-glycosidase and one glycosidase from genetically modified Thermotoga neapolitana strain were all examined in their efficiency for biosurfactant production. From lipases, the Humicola lanuginosa lipase showed the best performances for its use in reversed hydrolysis reactions. When this lipase was immobilized by adsorption onto the Accurel EP-100 polymer resin the preparation was characterized with 100% protein regeneration and total activity of 680 nmol/min/g preparation was achieved. Regarding the glycosidases, the β-glycosidase from genetically modified Thermotoga neapolitana strain showed the best performances. It showed almost 30 times higher selectivity toward the nucleophile donor in the transglycosilation reaction with a value for the r_S/r_H

parameter of 5.88 compared to that of the almond β-glycosidase having r_S/r_H value of only 0.20, almost 25 times higher selectivity compared to that of Aspergillus oryzae β-glycosidase having r_S/r_H of 0.24 and more than 9 times higher selectivity than the β-glycosidase from Escherichia coli having value for r_S/r_H of 0.65.

SDWS2012.0155 A Method to Implement BAT (Best Available Techniques) in South Mediterranean Countries: the Experience of BAT4MED Project

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Abstract

This paper describes our current experience from the BAT4MED project. BAT4MED is a project financed by the European Commission under the Seventh Framework Contract Programme (FP7). The main objectives of the project are to analyse the potential impact of the introduction of the Integrated Pollution Prevention and Control (IPPC) concept in the Mediterranean Partner Countries (MPCs hereafter) and, more specifically, if this can contribute to minimize the negative impacts associated with polluting activities from key industrial sectors.

The project brings together eight partners from six different countries: four partners from EU Member States (Belgium, Italy, Spain), three from MPCs (Egypt, Morocco, Tunisia) and one international organisation based in Egypt.

The paper focuses on the approach applied by the partners to introduce and disseminate Best Available Techniques (BAT) in two key industrial sectors in the MPCs. These are the two industrial sectors with the highest environmental benefit potential.

The paper summarizes the results of the first twelve months of the project. It illustrates the methodology developed for the identification of the two key industrial sectors in the MPCs. The methodology includes 25 different assessment criteria. The paper shows a series of quantitative and qualitative data on economic, environmental and social, health and institutional related aspects collected in the target countries and used in the selection.

The paper concludes with a description of the technical component of the project (which is ongoing), i.e. the development of BAT reports for the two key industrial sectors. Analogous to the approach followed by the European IPPC Bureau in the elaboration of Best Available Techniques Reference Documents (BREFs), Technical Working Groups (TWGs) are set up in each MPC. Technical audits are performed in 30 installations, technology databases are built and a methodology for assessing candidate BAT is designed.

Additionally the analysis on policy and legislative framework regarding pollution prevention and control will constitute the basis to set the Guidelines for an effective implementation of an integrated permitting approach in the MPC.

SDWS2012.0130 The Joint Effort Toward Developing Vertical Axis Wind Turbine Industrial Standard for Taiwan and China

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Abstract

Small wind turbine (SWT) has become one of the key industrial efforts for different countries to drive future development of distributed power system.Chinais the current largest SWT market in the world. The quantity of shipment of Chinese SWT products in 2010 was about 130,000, whereas that of Taiwanese in 2010 was about 7,500. Among which, 68% of Taiwanese SWTs were exported toChina. Manufactures ofTaiwanhas also shown strong superiorities on the design of Vertical Axis Wind Turbine (VAWT). There were general recognitions of promoting SWT industrial cooperation and strengthening technology level betweenTaiwanandChina, Therefore, institutes including Taiwan Institute of Economic Research (TIER), Taiwan Small & Medium Wind Turbine Association (TSWA), Chinese Wind Energy Association (CWEA) and Chinese Wind Energy Equipment Association (CWEEA) had reached the consensus to develop The Cross-Strait Join Standard for SWT Performance and Safety.

Most of the international existing SWT standards, including the IEC 61400-2, are originally developed for horizontal axis wind turbine (HAWT). It is a general tendency for the upcoming updating of international standards to consider the VAWT technology as an important part of the SWT standard. With global leading position for VAWT products ofTaiwan, the joint SWT standard development betweenTaiwanandChinawas decided to be performed with the standard of VAWT in precedence. A Cross-strait SWT Joint

Standard Development Task Force was formed in the beginning of 2011 and started to drive VAWT Industrial Standard. The target is to finish the drafted standard in June 2013 through intensive discussions among industrials from both sides. At present, the standard structure and the first edition of draft have been finished.

The draft has been prepared to follow the international standard developing trend as much as possible, and also has been emphasized to upgrade the VAWT technical requirements and product test requirements at the certified test site. One of the important technical items in the draft is the VAWT simplified load calculation model developed by Taiwanese industry. This item has long been absent in IEC 61400-2. This draft also adopts updating concepts now being developed in the third edition of IEC 61400-2.

Development of Joint VAWT Industrial Standard are participated by SWT manufacturers from both sides of Taiwan and China. Manufacturers from Taiwan are responsible for drafting major contents of it. Through periodical work team conferences between two sides, common consensuses regarding conflict technical concerns can be obtained gradually. This paper will expatiate the drafting process, current contents and important features of this under developing standard.

Renewable electricity generation systems II

Keynote presentation

SDWS2012.0470 Effect of Working Fluids on Organic Rankine Cycle for Geothermal Power Plant „Lunjkovec-Kutnjak“

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Abstract

Over the past 30-35 years, worldwide electricity production based on geothermal sources has increased significantly: the installed generating capacity has grown from 1300 MW in 1975 to almost 10,700 MW in 2010. In 1998 the Energy Institute “Hrvoje Požar” prepared a Program of Geothermal Energy Usage in the Republic of Croatia, which shows that in the Republic of Croatia there are some medium temperature geothermal sources (geothermal water) in the range from 90 to 170 ºC, by means of which it is possible to produce electricity in binary plants, either with the Organic Rankine Cycle (ORC) or with the Kalina cycle. However concrete initiatives for the construction of geothermal power plants have only recently been started. In accordance with this authors in previous papers have presented result of an energy-exergy analysis of geothermal resources Velika Ciglena (170 ºC), Lunjkovec-Kutnjak (140 ºC), Babina Greda (125 ºC) and Ružica (120 ºC), in order to determine which cycle is better for the conditions in Croatia. On the basis of analysis results that the ORC is thermodynamically better from the Kalina cycle for temperatures of all cited geothermal sources and cooling air, and considering the problems that all the new technologies encounter in their early phase of application, authors propose the application of binary plants using ORC cycle for all medium temperature geothermal sources in the Republic of Croatia. Researches related to the application of the ORC generally deals with the selection of the working fluid, optimization of the ORC unit and the whole plant and analysis of possible modifications with aim to increase its thermodynamic efficiency or net mechanical power output. Although in the available literature, there are a large number of published research results on the selection of the working fluid, however, every geothermal source is a case for itself with respect to the temperature of geothermal water and the cooling fluid on location (water or air). Therefore, in this paper will be presented the results of analysis of the working fluid effect on both thermodynamic efficiency and useful work and others cycle characteristics for the case of Geothermal Power Plant Lunjkovec-Kutnjak with temperature of geothermal water 140 ºC. As the working fluid the next refrigerants and

hydrocarbons will be analyzed: isopentane (C_5H_{12}), isobutene (C_4H_{10}), isohexane (C_6H_{14}), R114 ($C_2Cl_2F_4$), R141B ($C_2H_3Cl_2F$) and R142B ($C_2H_3Cl_2F_2$).

SDWS2012.0289 Costs of Electricity Generation from Different Sources for Small-Scale Rural Production in the Northeast Region of Brazil

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Abstract

The objective of this paper is to present the comparative costs of electric power generation (in euros per kWh) by using different sources, mainly the local sustainable ones in the 'Northeast Region' of Brazil. Energy is an important input for small-scale production in rural zones and the knowledge of its costs constitutes an important instrument for policy making, especially if we consider that a major program of rural electrification is underway in the country, the so-called 'Luz para Todos' ('Light for Everybody'), which intends to energize some of three and a half million houses in rural areas until 2014. In this paper, we are focusing four alternatives (i) biofuels accruing from local agriculture; (ii) electrification by conventional diesel generators; (iii) solar (photovoltaic generation), and (iv) electrification via expansion of the distribution networks. Most of the used data were drawn from a recent research entitled "Sustainable Local Energy Supply and the Small Scale Production for Distant Rural Communities in the Northeast Region - Brazil", supported by CHESF (the state-owned Brazilian company for energy in Sao Francisco Basin) and realized by University Federal Rural of Pernambuco. It is addressed, in addition, some of social and environmental aspects closed related with the electrification of rural zones. Among the final conclusions, we may say that costs of generation considerably vary and there is not a sole best way to electrify the communities. The generation costs strongly depend on the domestic market interest rates, which are very high in the country. In addition, the great obstacles to local rural development, even with the arrival of energy, continue to be the lack of financial resources in order to make the necessary and complementary investments and the lack of management skills among peasants in order to introduce new technologies and diversification.

SDWS2012.0164 Analysis of Photovoltaic Potential in Urban Areas: the Effect of the Eurozone Financial Crisis

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Abstract

The opportunity to integrate photovoltaic (PV) systems into the urban environment, avoiding the high cost of electricity transport, and the necessity of reducing $C0_2$ emissions caused by the use of fossil fuels, have led to consider the PV technology as a valid source able to significantly help to achieve the "20-20-20" renewable energy sources targets established by the European Union.

Nevertheless the success of PV systems installed in a dense urban contest mainly depends on the availability of buildings areas suitable for installation, the mismatch between generated and consumed electricity and the convenience of the economic investment. The above aspects must be correctly analyzed on the basis of both the survey of the city architectural layout and the economic assessment, which is linked with the costs for PV systems, the benefits due to the gain for the avoided bill costs and the electricity selling, the paid incentives and the trend of the weighted average cost of capital. The last index, which represents the thermometer of the potential impact of the recent eurozone financial crisis, has been on the rise since the second half of 2011 and may considerably modify the conditions of the PV market. Actually, the current financial insecurity and political instability have made the European homeowners reluctant to invest in PV systems to be placed on their roofs.

This study aims to test the feasibility of PV systems installed in a dense urban contest. A district of a city in the South of Italy (Palermo) was analysed in detail, also considering the Italian incentive plan, which was recently modified. The coverage of the electricity demand was investigated on the basis of the consumption of electricity of the households. The results of the energy assessment have been screened considering the economic feasibility of grid-connected photovoltaic systems. The proposed methodology permits to select a threshold number of floors of the buildings in correspondence of which the PV system that may be installed, and the consequent production of electricity, may not recover the costs for installation and maintenance of the system. Furthermore the realistic PV electricity percentage of the energy required to reach the “20-20-20” target in the city district was estimated. The energy cover factor of the district was assessed also considering its sensitivity to the main physical and economical parameters affecting the problem. Moreover the effect the time change of the financial situation and the effectiveness of the paid incentives was considered.

SDWS2012.0402 Design and Optimization of a Hybrid Wind-Photovoltaic Stand-Alone System for Tunnel Lighting

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Abstract

The moving force of the world today is energy. Although in the last few decades the mankind bases its development on abundance of energy from fossil fuels, the conclusion is that this type of energy is not only environment-pollutant but also not providing necessary stability, because of the fossil fuels depletion. As upcoming alternative we have renewable energy sources, which are environment-friendly and also almost abundant. Our task is to develop necessary technology, practice and experience to use them at maximum level and as much efficiently as we can. The objective of the paper is completion of an example for implementing renewable energy sources in traffic, as one of the largest energy-consuming segments of today's living. This example is realized through the design, optimization and techno-economic analysis of stand-alone hybrid system applied to tunnel lighting. Although Macedonia is an EU-candidate country, it has poor traffic infrastructure, especially in the field of tunnels and tunnel lighting. Few of the tunnels are illuminated with conventional lighting with significant energy consumption, costs and releasing CO_2 into the atmosphere. The goal of this paper is to provide energy-efficient and environment-friendly solution for tunnel lighting harnessing local renewable energy sources, especially sun and wind combined in a hybrid system using efficient LED luminaries. A design concept, including the three main system elements (photovoltaic field, wind turbine and battery storage), estimation of energy consumption, some optimization recommendations and control techniques using Matlab/Simulink are presented. At the end, a brief techno-economic analysis is provided to show the whole capability of presented system as very feasible and promising solution and in the same time expressing the potential and possibilities that Macedonia has in the field of renewable energy sources.

SDWS2012.0587 Wind Farm Monitoring Based on Computer Vision and Laser Optical Measurement Systems

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Abstract

Optical measurement systems utilizing computer vision and/or laser interferometry are introduced as a cost efficient alternative to the conventional wind farm monitoring systems that are currently in use. The proposed techniques are proven to provide an accurate measurement of the dynamic behavior of a 2.5 MW - 80 meter diameter - wind turbine.

Several measurements are taken on the test turbine by using 4 CCD cameras and 1 laser vibrometer and the response of the turbine is monitored from a distance of 220 meters. The reliability of the measurements is verified by comparing the 3D deformation and vibration data taken by the optical systems with the strain measurements taken by the strain gauges installed in the turbine.

The results of the infield tests and the corresponding analyses show that the computer vision technique (also can be called as photogrammetry or videogrammetry) enables the 3D deformations of the rotor to be measured at 33 different points simultaneously with an average accuracy of ± 25 mm, while the turbine is rotating. Several important turbine modes can also be extracted from the recorded data.

Similarly, laser interferometry (used for the parked turbine only) provides very valuable information on the dynamic properties (eigenfrequencies and damping values) of the turbine structure. 12 different turbine modes can be identified from the obtained response data. The measurements enable the detection of even very small frequency and damping shifts that can be encountered due to the changes in operation condition (pitch angle or wind speed). Therefore, they can be used for health monitoring and damage detection applications.

Optical measurement systems are very easily applied on an existing turbine since they do not require any cable installations for power supply and data transfer in the structure. Placement of some reflective stickers on the blades is the only preparation that is necessary and can be completed within a few hours for a large scale commercial wind turbine. These stickers can be used both for photogrammetry and laser vibration measurements and do not have any negative effect on the aerodynamic properties of the

turbine. Since all the measurement systems are located on the ground, a possible problem can be detected and solved easily. Optical measurement systems which consist of several CCD cameras and/or 1 laser vibrometer can be used for monitoring several turbines which enables the monitoring costs of the wind farm to reduce significantly.

Primary energy resources

Keynote presentation

SDWS2012.0482 New Nuclear Power Programs – Guidance and Experience

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Abstract

Over the past decades nuclear energy has been proven as reliable and economical energy supply that is capable of meeting demanding energy market requirements. Many countries around the world consider entering into new nuclear energy programs and building new power reactors for satisfying their increasing electrical energy needs in the long term. However, a nuclear power program is a major undertaking requiring careful planning, preparation and investment in time and human resources for building adequate nuclear infrastructure. Also, preparations for making a decision to enter into a new nuclear energy program requires a significant amount of financial and human resources, time, and assistance from already developed countries and international nuclear organizations.

The International Atomic Energy Agency (IAEA) from Vienna provides the methodology, technical help, financial assistance, and documented knowledge that are important for countries facing the challenge of entering nuclear programs for the first time. The IAEA organizes technical courses and information exchange meetings for new countries at which experiences and lessons learned are provided to new countries.

The IAEA has issued several documents that are of key importance as they describe the methodology for preparations that need to be made for making a decision to enter into a new nuclear power program. These document include the milestones document , the evaluation document , and the establishing infrastructure document , and others that cover this challenging topic.

In recent IAEA meetings relevant experiences were exchanged with countries that have used the IAEA defined process for making a decision and building nuclear infrastructure. These experiences have shown the complexities and challenges of the political, economical, social, technical, regulatory, educational and other issues that accompany such process.

This paper provides information about the methodology that needs to be followed for making a decision for entering into a new nuclear energy program, gives an overview of the IAEA documents and recommendations that are relevant, and discusses some of the

issues that have been encountered and experienced by countries that have embarked on such process.

SDWS2012.0265 Improvement of Existing Coal Fired Thermal Power Plants Performance by Control Systems Modifications

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Abstract

The necessity of the reduction of greenhouse gas emissions, as formulated in the Kyoto Protocol and EU directives, impose the need for improving environmental aspects of existing thermal power plants operation. Emission mitigation and efficiency increment in thermal power plants can be reached using primary or secondary measures, or by biomass co-firing, and they are usually accompanied by operational modifications or new equipment installation.

Most of electricity in West Balkan region is produced from coal fired thermal power plants which represents a great problem regarding pollutant emissions. Low efficiency of plants in operation is result of generally poor maintenance and lack of investments in power generation sector in the past few decades. Low quality coal used in coal thermal power plants proposes additional problem regarding pollutant emissions.

Advanced control solutions are developing technology and they represent promising improvement in the terms of power generation processes optimisation, emissions reduction and efficiency increment. Their impact depends on technical characteristics and status of existing instrumentation and control systems as well as on design characteristics and actual conditions of installed plant components. Burning process optimisation is strongest way to directly encounter emission and efficiency problems.

This paper is intended to present possibilities of implementation of advanced control concepts, and particularly those based on artificial intelligence, in selected thermal power plant burning process as part of primary measures for nitrogen oxide minimisation in order to increase plant efficiency, to lower pollutants emissions and to comply with environmental quality standards prescribed in large combustion plant directive.

SDWS2012.0439 Synergy Effects of Co-Combustion Coal with Wooden Biomass at 110 MWe Power Station Kakanj Unit 5

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Abstract

Co-combustion of biomass and bio-waste in coal-fired power plants is one of the most straightforward biomass applications in Europe. Paper presents research into cofiring of Bosnian brown coal and lignite with wooden biomass, as well as the findings of the co-combustion test at 110 MW_e Kakanj power plant Unit 5 supplied with low-ranking high ash brown coal and equiped with PF boiler with slag tap furnace, modern firing system with swirl low NOx burners and OFAS, and combined ESP and buggy dust filter.

The research in laboratory was aimed to optimize percentage of the switching the coal by wooden biomass in large coal-based power stations in Bosnia and Herzegovina. For purpose of the research, a 20 kW electrically heated entrained pulverized-fuel flow reactor was used. In the essence, combustion efficiency, ash-related problems and emissions were investigated. It was found that 7%wt of wooden biomass can be used in combination with coal in the power stations without risk to the combustion process and providing benefits through emissions reductions.

Based on the laboratory research findings, tests of co-combustion at the Kakanj power station unit 5 (110 MW_e) was adopted to the switching 5%w and 7%w of the brown coal by wooden biomass – spruce sawdust. Results of 15-days trial runs have confirmed some synergy effect of the co-firing of low-ranking brown coal with wooden biomass in regular operation of the Kakanj power station. Deposits from the co-firing campaigns are crisper and easier-to-remove than the deposits from the campaign with coal alone. This corresponds to a lower base/acid ratio for the deposits from the co-firing campaigns taken from the furnace outlet. The results indicate that the co-firing regimes come up with more intensive redistribution of alkaline components in the slag in melting chamber of the slag tap furnace, which consequently has a beneficial effect on ash deposition on the superheater surfaces of the boiler. Regarding the emissions, it was found that there is additional SO_2 reduction and no deterioration of NOx emissions in the co-firing campaigns. Dust emission in the cofiring campaigns is kept below 10 mg/m_n^3 at 6% O_2 dry. Moreover, currents at ESP are more then twice higher then in campaign with coal alone, resulting in more efficient operation of ESP in the co-firing regimes.

Synergy effects identified during co-combustion of coal with wooden biomass at 110 MWe TPP Kakanj Unit 5 can be ascribed to the specific characteristics of low-ranking brown coal used, particularly to the high content of ash and sulfur in coal as well as inconvenient ash chemical composition. Consequently, not only reduction of emissions than also mitigation of ash-related-problems may occur during co-firing of that coal with wooden biomass at certain weight ratio in large scale boilers under controlled conditions, as demonstrated in the power station Kakanj.

SDWS2012.0018 Adaptation of Bacteria of Anaerobic Digestion to Higher Salinity for the Application to Microbial Enhanced Oil Recovery

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Abstract

After the application of water injection, 60-70% of oil remains in the underground. It was estimated that if to increase oil recovery at 1%, the world would be supplied with the petroleum products during the whole year. Microbial Enhanced Oil Recovery applies injection of microbes producing gases, acids and other metabolic products to extract more oil from the oil reservoir. Only those bacteria should be selected, which would be able to withstand harsh conditions of the oil reservoir such as high temperature, high pressure and high salinity. It is known that to adapt microbes to higher salinity is easier than to higher temperature. For this reason, the selection of thermophilic bacteria with their further adaptation to high salinity seems to be reasonable. For the current study, bacteria of anaerobic digestion used for the biogas production at Ribe gas plant, Denmark, were chosen. The optimal temperature of their growth at the plant is 53^{o}C. Bacteria form a symbiosis of different bacteria producing methane mainly. The experiments were conducted to adapt bacteria to high salinities. 500 ml of water at the salt concentration from 70 to 100 g/l were prepared in the flasks and put to the oven at 53^{o}C. 50 ml of bacteria solution, 5 ml of molasses as a source of nutrient and 10 g of chalk for the acid neutralization were added. The volume of the produced gas was measured in a water displacement setup. After the gas production ceased in the second day, the maximum of the produced gas was measured at 70 and 90 g/l in the volume of 350 g/l. To revitalize bacteria and activate gas production, 200 ml of the water at the same salt concentration as was in the flasks and 5 ml of molasses were added. The gas was produced in all the flasks every day but in a different volume. On the 6th day of the experiment, the maximum of gas production was 1300 ml at 90 g/l and the minimum of 400 ml at 80 g/l. No correlation

of the bulk gas production with salinity was observed. The experiment shows that bacteria of anaerobic digestion can be an attractive candidate for MEOR implementation due to their ability to withstand high temperature and high salinity and produce gas in a large volume.

SDWS2012.0015 Groundwater Remediation in Cold Regions

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Abstract

There are many contaminated sites in Antarctica as a result of accidents or poor waste management. A significant proportion of the pollution is from oil and its derivatives and heavy metals. Although it's a common perception that hydrocarbon spills in frozen grounds are immobile, fuel components have been shown to be highly mobile in soils and sediments with low organic contents specifically during the summer melt season. The low temperature and low nutrient soils in cold regions make the natural attenuation rates much slower as compared to temperate climates. Therefore, more active remediation options are often sought for such sensitive areas. Permeable reactive barriers are one such option. They are an in situ passive treatment technology that removes dissolved contaminants from polluted water through subsurface emplacement of reactive materials and are widely applied.

But to install a successful PRB in cold regions, it's of paramount importance to understand the flow path and solute transport mechanism in frozen soils with proper understanding of axial dispersion and the reaction of solute along the flow path. This paper will discuss about the modeling tool to determine the contaminant transport behavior with minimal amount of data requirements, as acquiring significant amount of field data in such environments is not often possible. This study also investigates the impact of temperature and axial flow on the sorption column performance to adsorb hydrocarbons by studying breakthrough point and breakthrough curve at various flow rates and development of a model to predict the solute transport parameters. Toluene has been used as a representative soluble aromatic hydrocarbon in this study.

Inverse modeling has been utilized using the computer program CXTFIT to determine the variable parameters, axial dispersion coefficient and porosity. A set of partial differential equations was solved to describe the solute flow through, with appropriate initial and boundary conditions in order to develop a model to predict the future PRB and its performance in the field. The results indicated that the sorption capacity of the reactive media reduced by 25% at low temperatures, which implies much larger volumes of the media, would be required to install the PRB in cold regions as compared to the one in

temperate regions and needs to be considered at design stage. It was also found that the Langmuir constants best explain the column experimental data.

SDWS2012.0244 A Micro CHP Solution Based on a Micro Gas Turbine

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Abstract

In order to produce electricity and heat for a domestic application (familial house, small apartment building, offices building, …), a solution based on a micro gas turbine burning natural gas is presented. This very compact micro-CHP is intended to deliver about 5 kWe with a thermal efficiency of at least 30%. Such a solution will show to be highly adapted to a fully decentralized electricity production market, smart grids but also smart cities with a lot of electric vehicles.

The rational behind this attractive concept and the advantages compared with other micro-CHP systems will be explained, as well as the cycle design analysis and the architecture of the system based on these on-design calculations. This analysis will clearly show on which components of the complete system the research effort must be mainly put. The design of the heat recuperator (heat exchanger) will also be explained and a first technical solution proposed.

A proposal using green hydrogen as a fuel will also be detailed with all necessary changes.

A calculation for the RTI (return-on-investment) will be proposed for both fuel cases.

Buildings II

Keynote presentation

SDWS2012.0056 Time Trends of and Effects of Global Climate Chang on Residential Energy Consumption and Emissions of Pollutants

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Abstract

A portion of energy, mainly fuels and electricity, is used in residential sector for heating, cooling, cooking, lighting, and appliances. Consumption of residential energy, especially fuels is an important emission source of various air pollutants. For a better understanding of their environmental impacts, temporally and spatially resolved energy consumption and pollutant emission inventories are critical, Unfortunately, these data are extremely scare in developing countries including China. In this study, two models for predicting fuel and electricity consumptions in residential sector ofChinawere developed based on provincial data and tested against survey data on seasonal variations. It was found that two new terms, namely heating day, (HD, defined as the number of days when heating is required in a year) and power function based heating degree day (HDDp) can describe the residential energy consumption better than heating degree day (hdd). For electricity consumption prediction, per capita income is a critical parameter in addition to cooling degree day (cdd) and urbanization rate. The models were applied to predict spatial and temporal variations of and the effects of climate change on energy consumptions and emissions of various pollutants. It was predicted that total per-capita residential energy consumptions would reach 0.52, 0.38, and 0.28 toe/person in 2050 for the A1B, B1, and A2 scenarios. According to the modeling results, climate change in the future will lead to less fuel but more electricity consumptions. The increment of total residential energy consumption due to climate change will be 77 million toe (3223 PJ) and 18 million toe (753 PJ) in 2050 for A1B and B1, respectively. For all scenarios, emission of polycyclic aromatic carbons (PAHs), CO, and BC will decrease primarily because of the reduced need for heating fuels. On the other hand, emissions of CO2, SO2, and NOx will increase due to increase in electricity generation. As a rough estimation, climate change induced net change of PAH16 emission from residential sector in China in 2050 will be approximately -1.9, -1.5, and -1.9 ´103 tons for the three scenarios, which is equivalent to 5.9, 4.5, and 5.8% of the emission in 2007. Net increase of CO2 emission from residential sector due to climate change will be 826, 264, and 88 million tons in 2050 for the three scenarios, respectively, equivalent to 134, 43, and 14% of the emission in 2007.

SDWS2012.0335 From a Pilot Building to a Self Sustainable Energy Campus

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Abstract

The South East European University (SEEU) Climate Action Plan (CAP) represents the main project for decreasing CO_2 emissions by 35% in the next 10 years at the SEEU campus. This will be achieved by using renewable energy sources, energy efficiency activities and a behavior modification of employed staff and students. As a part of the CAP, a "pilot building" has been prepared from an existing building in which a number of technical solutions where implemented in order to achieve a Sustainable Energy Building. The "pilot building" represents a real lab for studying and analysis of renewable energy sources, geothermal and solar energies for the production of electrical and thermal energy. According to the measurements, analysis and results obtained in the "pilot building" and the development of the Energy Management System (EMS), the concept of the Self Sustainable Energy Building will be achieved. This is going to be a basis of the concept for the Self Sustainable Energy Camps.

SDWS2012.0332 Renewable Energy and Hydrogen Production for an Energy Self-Sufficient Building in Local Government

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Abstract

Nowadays, one of the greatest limitations in renewable energy widespread use lays in its intrinsic discontinuity; consequently, in order to efficiently satisfy building energy demand, an integration with energy storage systems is required if the use of traditional, fossil fuel plants is to be avoided. In this frame, recently hydrogen has shown to be particularly fit in order to be used as an energetic carrier. It can be produced using renewable energy sources, stored and used by means of fuel cells in advanced systems.

Consequently, research for hydrogen sources useful for feeding hydrogen-air fuel cells represents at the moment an important research aspect. On the other hand, greenhouse gas emission reduction is one of the main challenges to be faced up in order to control dangerous climate changes. For this reason it represents the fundamental matter of international agreements, aiming at reducing gradually and effectively, the greenhouse gas emission rates. In order to achieve these targets, particular attention must be paid to the control of excessive use of fossil fuels. At the moment, a significant portion of the total primary energy is consumed in buildings and can be significantly reduced by adopting energy efficiency strategies and using renewable sources. Consequently, it is strongly recommended by the European Directives to achieve quasi-zero energy buildings (e.g. passive buildings). Within this frame, in this paper an auto-sufficient system for energy production and storage in buildings is presented. The designed system integrates a photovoltaic plant for the conversion of solar energy into electric energy, an electrolyser for hydrogen production, a pressure tank for hydrogen storage and fuel cells for electric energy conversion. The system is applied to a local government building housing ARPACAL (Regional Agency for Environmental Protection of Calabria): the whole plant allows both to make the building independent on the electric network and to overcome energy use dependence on the typical discontinuity of solar energy. In particular, the study presents the simulation, on a daily, monthly and yearly base, of the system energy behaviour, allowing evaluation, from an energetic and economic point of view, of the sustainability of the selected stand-alone plant typology, also on the basis of economic incentives provided by the Italian Government for energy production from renewable source.

SDWS2012.0568 Improving the Thermal Performance of the Transparent Building Envelope: Finite Element Analysis of Possible Techniques to Reduce the U-Value of the Glassblocks

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Abstract

Glassblocks are widely used as transparent materials, especially when large interior areas must be illuminated by solar radiation. In these cases it is possible to use glassblocks as bricks to obtain translucent walls. In comparison to glazed windows surfaces, glassblocks often have higher thermal resistance due to the higher thickness of the layers. However,

although the greater thickness of the glassblocks is comparable to that of opaque walls, the thermal performance is generally worse. Therefore, standard glassblocks generally have high U-values in comparison to the maximum values allowed by energy efficiency standards for glazed surfaces.

The ability to predict the energy performance of transparent surfaces is of great importance in the assessment of the overall energy performance of buildings. Indeed, heat transfer through glazed surfaces is very often the most important type of the transmission heat losses during the winter season. For this reason, it is important to correctly assess the global thermal transmittance, U-value, [W/m^2 K] of glazed elements.

This paper presents a detailed report on the thermal properties of the glassblock and propose a summary of possible solutions (someone derived from a patent survey) that could improve its thermal performances. We have investigates some possible technological solutions that applying of thermal breaks, translucent and insulating fillers (i.e., aerogel) or adding multiple sheets to subdivide the glassblock's cavity into two or three parts, permit to decrease the U-value.

The new configurations of the glassblock has been defined by schematic models and their overall thermal resistance has been assessed by the means of Finite Element and CFD software, that was calibrate with a previous thermal analysis based on an empirical lump parameters approach.

The resulting performances are presented in terms of the global thermal transmittance of the modified glassblocks, also considering the effects of sealing and mortar. The paper also shows some significant potential improvements to address new production lines.

Further analysis has been conducted by authors to assess the light transmission, solar factor of the investigated glassblock and other different configurations, which will be presented in future papers.

Water resources

Keynote presentation

SDWS2012.0353 New Architectural Forms to Increase Dew Collection

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Abstract

The goal of the study is to find new families of shapes for dew condensers that provide more dew water. An exploration of structures on small models is initially carried out. In the second time, prototypes are built for outdoor experimentations, using a meteorological station and a device (pluviometer-like) to evaluate the amount of collected dew. Then the yields of the new collectors are compared with a reference collector made up of a simple planar dew condenser tilted 30° with horizontal, a shape that is currently used for measurements (and also correspond to a roof slope).

Conical shapes have been already studied (see Jacobs et al. . Atmos. Res. 87, 377, 2008; Clus et al., Desalination 249, 707, 2009). They show in average 140% larger yields than the planar reference condenser when the cone half-angle is 30°. Two new families of forms (egg box and origami types) were eventually retained and built on scale 1/1. Two roofing units, of approximately 4 m²each, were erected at Pessac(France) at about 45 kmfrom the Atlantic Ocean during summer and fall of year 2009. The collectors are set above the ground and face the sky. For a good performance, the external surface is coated with a paint containing an additive that makes it hydrophilic and gives it a high infra-red emissivity. Each condenser is coated below with a Styrofoam thermal isolation.

The first type of condensers resembles egg boxes. The prototype is made with epoxy. The external surface is polished and painted with the additive noted above. The behaviour of this condenser is related to the effects of the modular play of its warped surfaces and double curvatures.

The second kind is of origami type. The receiver is made out of galvanized steel with 30° angle. The water yield will be related to the angular and folded nature of the structure. This device is painted by using the same additive as above. The insulation between the steel plates is fixed below them.

The results are striking. The egg-box family shape gives 120 % more water than the reference planar condenser, a result independent of the dew yield. In contrast, the origami shape gives yields 150% larger than the reference planar condenser at large dew volumes and 400 % larger yields for low dew volumes. These results are analysed and discussed in terms of (i) radiative effects correlated with the angular variation of the sky emissivity , (ii) heat losses by free and forced (wind) air convection and (iii) gravity water flows. General rules to increase dew collection then follow.

SDWS2012.0116 Multi-Attributive Methodological Approach to Prokletije Water Resources Management

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Abstract

Developing of optimal small hydro system and designing of an optimal concept of hydro potential exploitation of the rivers in the region, pose several questions. The first one is: what is the maximum possible and what is the real energy efficiency of the profiles analyzed? From which parameters does it depends on? This paper is presenting the new methodology for optimal concept selection of small hydro development, by using artificial intelligence. Mathematical methods of operational research are used for quantification of environmental, social, political and cultural parameters and its incorporation in the concept of small hydro development optimization. System of small hydro power plants optimization for Prokletije streams catchment area is case study where the developed methodology is tested and proofed. There are for streams, with few tributaries, presenting the catchments area of Prokletije mountain in Monte Negro. The head is imposing and the discharge is not to variables and not to small. Fifteen possible small hydro power plants has been analyzed. Elektra method had been applied, as possible multi attributive operational research model. Delphi method has been used for quantification of environmental and social impacts, which are results of Environmental and Social impact assessment study of the project. All necessary calculations and technical, economical, environmental and social analysis has been done for each of fifteen small hydropower plant separately and for the eight possible system of hydro potential exploitation of the river. The adopted optimal compromise solution was the system composed of three small hydro power plants. The main goal of this paper is to present the methodology of artificial intelligence method application in environmentally friendly optimal concept selection of small hydro development. The conclusion is that small hydro concept, defined and

selected by this methodology achieves the maximum possible realistic energy efficiency of the hydro profiles.

SDWS2012.0132 Water Resources Analysis in Alto Aragón in the First Decade of the 21st Century: Water Demand, Efficiency and Productivity.

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Abstract

Agricultural water use has a special interest because it accounts for nearly 80% of the water uses in Spain. Specifically, irrigated farming has become the main user. Irrigated farming has had a key role in the economic development in Spain, and nowadays irrigation productivity gains are relevant for the viability of existing farms and to deal with the growing external demand. This paper aims to analyze the evolution in recent years of the water situation in the Riegos del Alto Aragón (127.210 ha), a major irrigation scheme in north-eastern Spain. We study the evolution of water demand, irrigation efficiency, water and land productivity, the most profitable crops and cropping patterns. The results indicate that water scarcity can provoke cropping pattern changes to less-water-demanding crops. The lower profitability of these crops can be a conflicting objective versus the strong investments in irrigation modernization. The future and sustainability of irrigated farming should not aim to reduce water supply and the most profitable and demand crops, but to focus on these crops, to increase irrigation efficiency and to ensure the water availability.

SDWS2012.0269 Triple Win Strategy for Reservoir Watershed Management by Game Theory

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Abstract

A multi-objective and game-theoretic programming approach (MAGPA) is illustrated to discuss the suitability and significances in the problems of sustainable watershed management. In this study, game theory is used as an alternative tool for analyzing strategic interaction among triple objectives - economic development (land use and

development), social concerns (equality and tax) and environmental protection (water-quality protection and eutrophication control) - in the watershed management. The MAGPA is illustrated in a case study of multi-objective watershed management in the Tseng-Wen Reservoir,Taiwan. Results show innovation and advantages of the approach in which analysis of economic, social and environmental equilibrium within watershed management can be easily interpreted to aid the decision makers for watershed management. Moreover, for comparison, the conventional multi-objective method was analyzed in which the decision making process is difficult to determine. The application of MAGPA is further discussed in this study.

SDWS2012.0242 Renewable Energy Powered Natural Vacuum Technique for Seawater Desalination

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Abstract

The present study deals with the applications of natural vacuum technique for seawater desalination and waste water treatment systems for different climate regions using renewable energy sources together with integrated conventional energy systems or nuclear power plants. A new desalination or waste water treatment technology named Natural Vacuum Desalination is proposed. The novel desalination technique achieve remarkable energy efficiency through the evaporation of seawater under vacuum and will be described in sufficient detail to demonstrate that it requires much less electric energy compared to any conventional desalination plant of fresh water production of similar capacity. The discussion will highlight the possible application methods of the proposed natural vacuum desalination method for the desalination in different climatic regions and the waste water treatment for the cold climatic regions ;which seems to have promising techno-economic potential providing also advantageous coupling with renewable energy sources and waste heat.

SDWS2012.0532 Tamis Water Resources, Related Ecological and Environmental Problems and Perspectives

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Abstract

The Tamis is a 359 km long river originating fromCarpathian mountains. It flow through the northernSerbia (Banat region-Vojvodina) and the mouth into theDanube is near Pancevo town. The river flows throughRomania for 241 km and 118 km throughSerbia. With Danube it belongs to theBlack Sea drainage basin. This paper is presenting the main Tamis water quality parameters, pollutants and necessary monitoring, protection measures and water resources management perspectives. Measurements of water quality in Vojvodina have indicated general conclusion that majority of pollutants reach water through runoff from agricultural land and from industrial and public sewage systems located along the watercourse and canals. Industrial waste water contains high concentrations of conventional pollutants (e.g. oil), toxic pollutants (e.g. heavy metals) or other non conventional pollutants such as ammonia. Sediment washed off fields in the largest source of agricultural pollution. Nutrients (nitrogen and phosphorus) are typically applied to farmland as commercial fertilizer. Farmers also use animal manure to fertilizer the soil. Industrial waste water and agricultural waste water need specialized treatment system to remove the toxic components, before we can let it go to the river. Public sewage water must be channeled or piped out of the city and villages for treatment. This kind of waste water contains water with organic waste and chemicals. Draining the water without treatment is one of the major causes of river water pollution. Pathogenic microbes present in sewage water spread many different diseases. These pathogens pose a great risk to human health.

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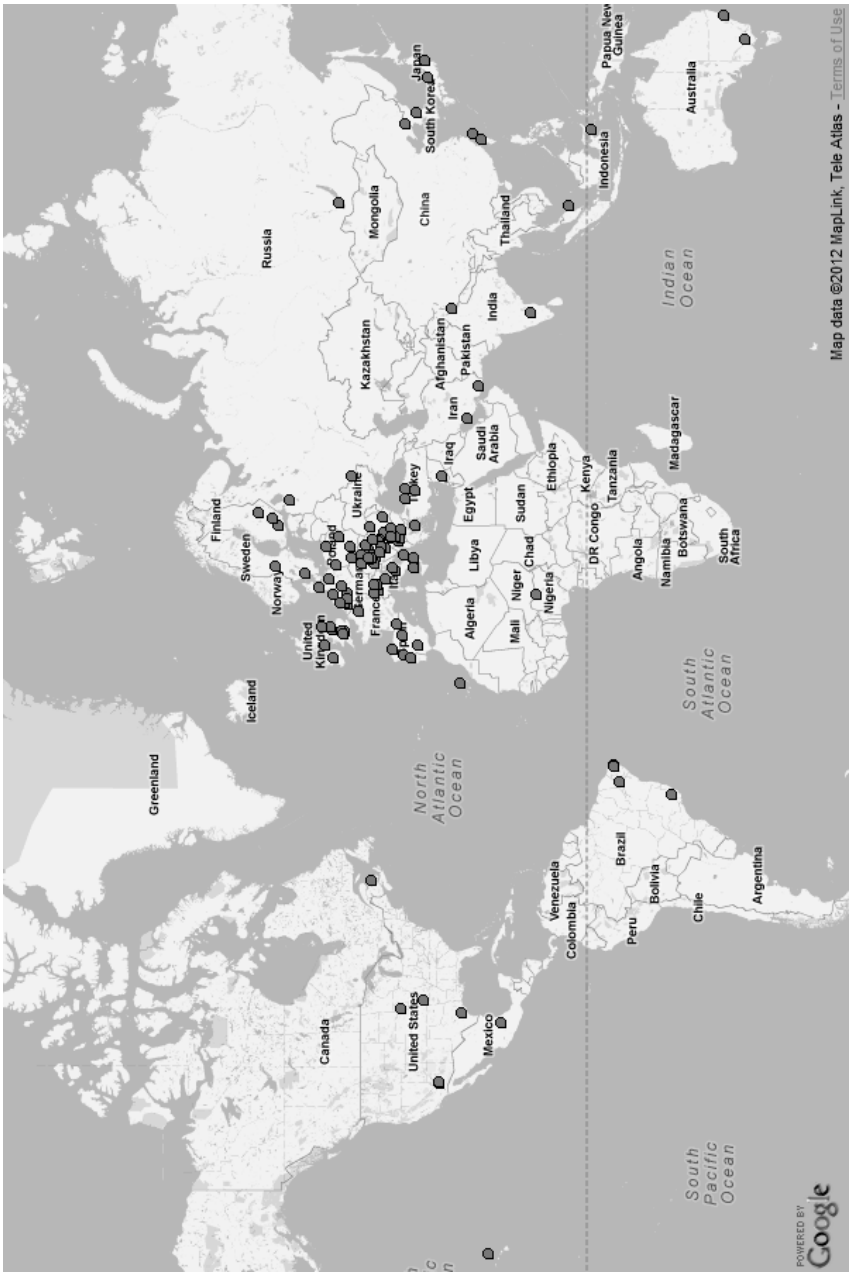

SDEWES participants from 6 continents, 45 countries, around 115 cities and 170 universities institutes and companies.