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Network Flow Models and Local Environmental Impacts

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Keywords: NERUDA; Waste; Waste-to-energy; Emissions

Network flow models are considered a useful decision-supporting tool for processing infrastructure planning. There are various models for such plants and flow allocations. They differ in terms of complexity and demand on input data. Typically, the goal of the calculation is minimized cost or minimized environmental impacts. Sometimes both are combined within bi-objective functions. Whereas global environmental impacts such as greenhouse gas production are commonly used in objective functions, local environmental impacts tightly connected to human health are rare.
The contribution introduces a new approach, where emissions and their dispersions are addressed in the network flow model for waste processing infrastructure planning. The approach extends the existing tool NERUDA. NERUDA proposes locations and capacities of waste-to-energy plants considering the production of waste not suitable for material recovery in 203 microregions of the Czech Republic. Collection areas of individual projects and transportation systems are proposed at the same time. The extended model calculates emissions produced in the waste-to-energy plants and saved in fossil-based utilities thanks to heat and power delivery from waste-to-energy first. Then these emissions are dispersed in the surrounding and resulting ground concentrations are interfered with the population exposed to these concentrations. Suitable criteria (human toxicity, disability-adjusted life years DALY, etc.) entering objective function will be discussed.

A Comparative Environmental Impact Study of Ground Source Heat Pump Systems

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Keywords: Geothermal Energy; Ground Source Heat Pumps; Environmental impact; Life Cycle Analysis

Ground Source Heat Pump (GSHP) systems are the main application of Shallow Geothermal Energy (SGE) systems, which are categorized as a RES. The GSHP systems consist of ground heat exchangers (GHEs) and HPs and they are used for space heating and cooling, exploiting Geothermal Energy. An important feature of RES is whether they are also “green” or ecological. Hence, this study focuses on the ecological aspect of GSHP systems, examining case studies in Cyprus and other European countries for residential buildings with high and low heating and cooling loads. The ground thermal characteristics and the peak heating and cooling loads of specific residential buildings of constant area are first used to determine the GHE length and the GSHP Coefficient of Performance (COP) by the GLD software. Next, a Life Cycle Analysis (LCA) of the systems is employed to estimate the environmental impact of all cases. The yearly heating and cooling load of the building is set as a functional unit, with the system boundaries containing the GHEs manufacturing and the operation of the system. An Air Source Heat Pump (ASHP) system is set as the baseline. The GSHP systems are compared to the baseline in percentage deviation, as, although the GSHP system is of higher COP than ASHP systems, it is not necessarily a more environmental-friendly solution in all cases. The LCA comparative results indicate that the location of the installed GSHP system play an important role in the magnitude of its environmental impact.

Analysis of Electric Consumption Patterns in the Hungarian Housing Sector Using Clustering Techniques

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Keywords: Electric Energy Consumption; Clustering; Smart Metering; Consumption Patterns; Demand Side Management; Occupant Behaviour

One of the widely researched key areas related to energy efficiency of buildings is the impact analysis of occupants' behavior on energy use and the possibilities of influencing the behavior. The critical point for a deeper understanding of the topic is the availability of high quality large scale data and certainly the appropriate data analysis techniques. In this paper, we describe a research project aiming at the analysis of a smart meter database containing data from nearly 5,000 buildings from all over Hungary. In the project, typical daily and monthly electricity consumer profiles were determined using different clustering methods. The composition of the examined buildings is heterogeneous, there are old and new ones, both single-family houses and apartments, the analysed meters included peak and off peak meters. All this made it possible to differentiate the results and to analyze the effect of different parameters. The work has been carried out within the research project entitled "Large Scale Smart Meter Data Assessment for Energy Benchmarking and Occupant Behavior Profile Development of Building Clusters". The project (no. K 128199) has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the K_18 funding scheme.

Market Premia for Renewables in Germany: The Effect on Electricity Prices

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Keywords: Negative Electricity Prices; Merit Order Effect

Due to the growing share of "green" electricity generated by renewable energy technologies, the frequency of negative price spikes has substantially increased in Germany. To reduce such events, in 2012, a market premium scheme (MPS) was introduced as an alternative to feed-in tariffs for the promotion of green electricity. Drawing on hourly day-ahead spot prices for the time period spanning 2009 to 2016 and employing a nonparametric modeling strategy called Bayesian Additive Regression Trees, this paper empirically evaluates the efficacy of Germany's MPS. Via counterfactual analyses, we demonstrate that the introduction of the MPS decreased the number of hours with negative prices by some 70%.

Lowering CO_2 Emissions and Carbon Footprint Using Algae Cultures and their Application to Arable Land

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Keywords: Algae; Torrefaction; Carbon Dioxide Reduction; Environment; Carbon Footprint

Current trends include reduction of gaseous pollutants, especially the “carbon footprint”. There is an effort to make production processes, product concepts, operations, energy and other processes, as well as ordinary human activities, more environmentally friendly. Among the topics addressed at our workplace is research in the field of energetics and environment, one of them namely CO_2 removal from monitored processes, regarding to carbon neutrality as a long-term goal of the EU visions.
Our workplace, in cooperation with other research organizations, is trying to find a way to reduce the carbon footprint, using experimental methods to create an environmentally friendly cycle based on the use of CO_2 consuming algae cultures and their subsequent processing.
Algae bio-fix CO_2 (from the atmosphere or gas), which they need for their growth, and thus reduce the overall carbon footprint. Therefore, we cultivate algae to capture CO_2, then flocculate and filter them in an underpressure or vacuum environment (to make the filtration process as fast as possible). The separated algae are dried but, to save energy for drying, it is advisable to add moist algae directly to the mixture for subsequent pellet production. The mixture for the preparation of pellets must be of a certain dampness. If the mixture were too dry, they would be crushed and improperly compressed on the matrix of the pelletizing machine.
To achieve the highest possible yield and efficiency of CO_2 consumption, it is important to set up and test varying “operating” conditions for the growth of algal cultures, and to study the microbiological risks and pests of these cultures.
The mixture for the production of pellets is based on algae, chicken manure and wood waste biomass. We designed this mixture in cooperation with the staff of the Technical University of Koszalin (Poland) based on operational tests and the suitability of conditions for application in the agricultural sector. The resulting mixture can be used for mixing with the algal filtrate and subsequently for further trials and experiments, especially in torrefaction and subsequent application.
For the thermal processing of pellets, it is possible to use torrefaction up to a maximum temperature of 300°C, up to which the bound carbon is not released from the algae and remains in the pellets. It is the torrefaction that changes the properties of the pellets, which can be further used as a fertilizer and anti-erosive additive in agriculture. In addition, these pellets bind to themselves other soil nutrients and other applied artificial fertilizers (e.g., based on nitrates and phosphates), so that these are not washed away by rain, thereby increasing the efficiency of the overall nutritional effect at the application site. Simultaneously,

the addition of algae fosters the return of CO_2 from the atmosphere to the earth. An alternative method is to add algae concentrate to the feed of domesticated animals, especially cattle.

It should be stated in advance that it is not recommended to burn these pellets, even though they are a lucrative fuel, as this would re-release the CO_2 back into the atmosphere.

The Post-Growth Transformative Capacity of Energy Communities in Greece

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Keywords: Post-Growth; Transformations; Energy-Communities; Energy; Sustainability

The overlapping and mutually-reinforcing crises of climate change and rising socio-economic inequality, will determine the course of human development in the 21st century. The centralized, fossil-based polluting energy system of today is slowly undergoing a transformation towards renewable energies, but the nature, scale and speed of the transformation has repeatedly come into question. A mere switch in technologies, without a thorough examination of underlying socio-economic relations and power structures, risks perpetuating the same crises of inequality and ecological degradation of the previous system. It becomes clear then that a new energy system is required which simultaneously enhances human well-being, whilst respecting planetary boundaries. Energy communities, legally recognized through the 2018 revision of the EU RED II, may offer this third system alternative. Greek legislation explicitly frames energy communities as part of the social and solidarity economy and specifically as a tool to tackle energy poverty. Coupled with strong ecological sustainability targets, energy communities could well be suitable candidates for an energy future that is both socially and ecologically sustainable. The present research weaves together transformations and post-growth literature and constructs a qualitative analytical framework against which an initiative's post-growth transformative capacity can be tested. It then zooms back in to apply the framework specifically on energy communities in Greece. Results showed that Greek energy communities hold significant post-growth transformative potential, in areas such as networking, actor empowerment and innovative learning, shared vision creation, alteration of resource flows and a reconfiguration of ownership and governance structures. The research concludes with some policy recommendations that could further enhance the post-growth transformative capacity of Greek energy communities, such as the creation of a national federation of energy communities. Finally, the post-growth transformative capacity framework presented in this research could be used as a as a descriptive and partly normative starting point, from which academics or practitioners can build on to explore post-growth futures and post-growth transformative capacity in other sectors (e.g., food or transportation) and contexts (e.g., Global South countries).

A Reinforcement Learning Approach for the Real-time Energy Management of a Smart Home

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Keywords: Smart Home; Energy Management; Storage System; Reinforcement Learning

Smart homes that contain renewable energy sources and storage systems will be key components of the future smart grid. Traditionally, the smart homes' energy management issue is formulated as a sequential optimization problem that is solved through commercial solvers by taking into account forecasts of stochastic variables. In the big data era, Reinforcement Learning (RL) techniques that do not rely on stochastic variables' predictions and expensive optimization solvers can be used for developing energy management schemes. RL is the process where an agent learns what to do (action) in a given situation (state) by interacting with an environment to maximize numerical returns (rewards).

In this work, we develop a RL-based scheme for the real-time energy management of a smart home that is equipped with a Photovoltaic (PV) system and an Energy Storage System (ESS). Under a Time of Use (ToU) electricity tariff, the objective of the proposed scheme is to minimize the electricity supplying cost by appropriately scheduling the ESS on a daily basis. The problem is formulated as a Markov Decision Process (MDP) with continuous state and action spaces, which is optimized using Deep Deterministic Policy Gradient (DDPG), an RL algorithm that is suitable for problems containing continuous variables.

The main advantage of our proposed method compared to optimization-based ones is the ability to obtain effective daily schedules without relying on stochastic variables' forecasts. In addition, nonlinearities related to the operation of the smart home's components can be effectively modeled, without the necessity of approximating them, as in methods that apply linear optimization techniques.

In the existing literature on RL-based energy management, the RL algorithms are trained based on a historical dataset, and then they generalize the obtained knowledge on newly encountered situations. In our work, the K-means clustering algorithm is used to partition the initial historical dataset into day-type subsets that consist of more homogeneous load demand and PV generation data points. Then, a separate DDPG agent is trained for each day-type subset. In this way, the training process becomes more targeted since the agents gain experience from days that have similar demand and generation profiles. In addition, the generalization process becomes more accurate because any forthcoming day in the test set is first assigned to one of the predetermined subsets, and then, the agent that has been trained based on the information of that subset is loaded to the EMS for taking real-time decisions for the ESS's set points.

Towards an Innovative Economical Mechanism for the Energy Renovation of Hotels. The CREnHOM Project

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Keywords: Energy Retrofit; Hotel Investments; Energy Performance Contracting

It is necessary to move on to energy performance solutions in order to meet the environmental objectives, but also to reduce the energy consumption of the building stock and the expenses of the tourist industry in conventional energy sources. Therefore, the research question of this study is “How could the Energy Performance Contracting (EPC) be a financing mechanism to promote energy efficiency renovations in hotels?”
This study was carried out in the framework of the interregional project CREnHOM (Cross-border cooperation between France and Switzerland), whose main objective was to propose solutions to accelerate the energy renovation of the hotel park in the Alpine region. Seventeen qualitative interviews were conducted with different stakeholders (hotel owners, investors, construction companies, ESCOs) regarding the motivation and barriers to energy renovation. The aim was to explore the initial situation of the renovation market. The study uses a framework based on a multi-dimensional approach proposed by Buffa et al (2018) based on environmental management practices for sustainable business models in small and medium sized hotel enterprises.
In terms of methodology, the study aims to compare the pilot projects that have been carried out in several Alpine regions in Switzerland with a goal to present the results regarding the feasibility of EPCs. The medium-term results focus on how to decrease the barriers observed in order to obtain hotel renovations through EPCs. In addition, the study allows us to understand which model to implement in order to reduce the risk and ensure a financial return on the funds invested to encourage the hotels proceed in energy renovations. The main obstacles established, for the implementation of an EPC will be presented. According to the study, in Switzerland auto-financing was still sufficient for the time being and so the actors are not necessarily looking for alternative financing options. The need for a performance guarantee is more important than the search for a financial solution. Clients need guarantees and results. Moreover, in some

cases the investments for renovation actions were not significant enough in terms of energy savings to justify the use of an EPC.

This article presents the results of the project as well as our future objectives in the field. The Covid-19 crisis has had an impact all over the world, and of course on the tourism sector. This crisis can be considered as a "tipping point" that forces us to look for innovative solutions in order to accelerate energy renovations in the tourism sector. Our future scientific objectives regarding this study are to broaden our research to investigate whether the motivations of the hotel owners have changed after the Covid-19 crisis regarding their willingness to carry out energy renovations.

Efficiency and Design Aspects of Ground Heat Exchangers: A Parametric Analysis

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Keywords: Geothermal Energy; Ground Heat Exchanger; Ground Thermal Properties

Shallow Geothermal Energy, a Renewable Energy Source, finds through Ground Heat Exchangers (GHEs) of various configurations (mainly vertical U-tubes, but also horizontal or spiral) that extract or reject heat from / into the ground. The sizing and consequently the cost of such systems (GHEs in conjunction with Ground Source Heat Pumps – GSHPs) depend on various factors. The objective here is to examine the factors affecting the sizing and positioning of GHEs in the Mediterranean environment of Cyprus. There is indeed a large number of parameters involved in the design of such systems, and the desired result can be achieved in various ways depending on the considered parameters. This is done through simulations by commercial design software programs (e.g. GLD) in combination with test data. The parametric study investigates the influence on the performance of GHEs of: (a) the temperature, (b) thermal conductivity, specific heat and density of the ground, (c) pipe diameter (of the GHE). Another important factor studied is the long-term temperature variation of the ground around the GHE boreholes, which affects the positioning of the GHEs. The main outcome of the parametric analysis is that – generally speaking – Cyprus constitutes a proper environment for the application of GSHP/GHE systems. The performance of the GSHP is not affected by the ambient conditions as the ground temperature remains unchanged.

Microalgal Technology for Carbon Capture

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Keywords: Microalgae; Carbon Capture; Photobioreactors

Increasing carbon dioxide (CO_2) concentration in the atmosphere is responsible for global warming as it was demonstrated in many studies. CO_2 emission released from combustion processes is the problem important not only from the environmental point of view but also from the global economy perspective. Long-term sustainable capture of CO_2 in terms of the environment and the economy is important for the restriction of increasing CO_2 concentration in the atmosphere. Therefore, the development of novel technologies for recycling of carbon compounds especially for waste CO_2 from the flue gas is necessary. Currently, great attention is paid to the usage of microalgae for waste CO_2 capture through photosynthesis. The main benefit of microalgae is high efficiency of CO_2 capture. The efficiency of microalgae is nearly 50 times higher compared to plants. Moreover, through the metabolism of microalgae, CO_2 captured using photosynthesis can be converted to usable products such as valuable compounds, biodiesel or biogas. However, high efficiency of CO_2 capture using microalgae depends on several factors such as strain tolerance to flue gas compounds, effective cultivation technology and optimization of cultivation systems. Therefore, presented study was focus on selection of fast growing resilient strains of microalgae with high capacity for CO_2 capture. Ten microalgal strains were evaluated in terms of CO_2 bio-fixation and biomass productivity. However, experimental results seem promising, it is necessary to solve several obstacles included achievement of high CO_2 capture efficiency, processing of produced biomass and positive economic aspects of microalgal cultivation.

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Climate Changes during and after the Lockdown (COVID-19) in the North-Western Cities of Morocco

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Keywords: COVID-19; Air Quality Index; Pollution; Lockdown; Morocco

As a response to the rapid propagation of COVID-19 among Moroccan population, all the industrial activities were suspended since 20 March 2020. The present study investigates the possible change on atmospheric pollutants rate during the imposed lockdown. Through using the satellite data from NASA Earth data, which provides estimated emissions of pollutant into atmosphere, we explore the change on air quality in the North-Western cities of Morocco focusing on main atmospheric pollutants; NO_2, NO, PM10, PM2.5, CO and O_3. The results indicated that NO_2, NO, and CO levels were reduced by 52%, 66%, and 53%, respectively, resulting in a decrease in road traffic by 75%. However, O_3, PM10, and PM2.5 were increased by 10%, 13%, and 53%, respectively, during the lockdown. The increase in ozone is explained by the decrease in NO and other gases associated with human activity, which can consume ozone. Thus, the trend of ozone shows a positive correlation with some metrological parameters like solar radiation, sunshine, temperature and humidity during confinement. In addition, the increase in temperature increases the emissions of volatile organic compounds (VOCs) and the oxidation of these species leads to the formation of ozone and organic aerosols, which also explains the increase in PM during containment. This study shows the role of atmospheric photochemistry in air pollution.

$La_{0.7}Sr_{0.3}BO_3$ (B=Fe, Mn, Co) Perovskites as Oxygen Carrier Materials for the Preparation of Dual Phase (combo-DP) Membranes for CO_2 Separation

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Keywords: CO_2 Separation; Perovskites; CO_2 Capture; Oxygen Carriers

Carbon dioxide separation with membranes is a promising alternative method for CO_2 capture from the flue gases of industries. Dense dual phase membranes (combo-DP) are a new type of membranes with theoretically high selectivity of CO_2. They consist of a porous ceramic phase with high ionic conductivity and a molten carbonate phase that fills the pores at operating temperature. The CO_2 separation takes place on the ceramic surface of the membrane where a CO_2 molecule reacts with the lattice oxygen of the ceramic material and converts into a carbonate ion CO_3^{-2}. The carbonate ion can be transported through the molten carbonate phase to the other side of the membrane where the reverse reaction takes place. Perovskite materials are ideal candidates for the preparation of porous ceramic support of the combo-DP membranes, due to their ability to reversibly pick up and deliver oxygen and their high ionic conductivity. In the present work perovskites with the general formula $La_{0.7}Sr_{0.3}BO_3$ (B=Fe, Mn, Co) were studied as potential materials for the preparation of porous membranes. The perovskites were synthesized with the co-precipitation method and calcined at 1000°C. The powder samples were evaluated for their redox ability at a thermogravimetric analyzer IGA (Hiden-Isochema) with simultaneous chemical analysis of the exit stream by mass spectrometry. The evaluation was performed at constant temperature (920°C) and pressure (1050 mbar) with He as the carrier gas. The samples were reduced with CH_4 and oxidized with O_2 during 8 successive redox cycles and they presented remarkable stability. The sample $La_{0.7}Sr_{0.3}CoO_3$ showed the highest oxygen transfer capacity 8.11 wt.%, after 8 successive redox cycles. The oxygen transfer capacity of the examined samples decreased in the following series $La_{0.7}Sr_{0.3}CoO_3 > La_{0.7}Sr_{0.3}FeO_3 > La_{0.7}Sr_{0.3}MnO_3$

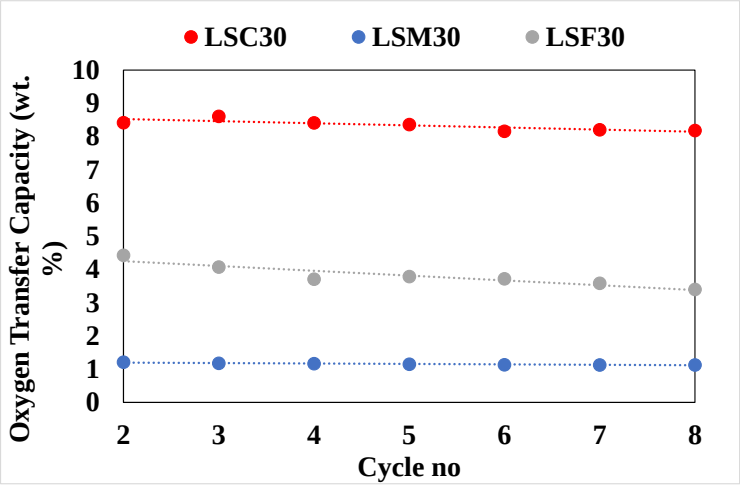

Fig. 1: Oxygen Transfer Capacity of $La_{0.7}Sr_{0.3}BO_3$ (B=Fe, Mn, Co) perovskites after 8 successive reduction (CH_4)-oxidation (O_2) cycles at 920°C

(Fig. 1). The reduced and reoxidized samples were analyzed with X-ray diffraction. The analysis indicated the formation of metal oxides and La_2O_3 at the reduced sample, while the reoxidized samples after 8 successive redox cycles return to their original state indicating structure stability. The calcined powders were granulated with Polyvinyl Alcohol (PVA Merck, 1% w/v) as a binder and carbon black (CABOT, VULCAN XC72 GP-3907) was used for the pore formation. The powders were uniaxially pressed and then sintered at high temperatures achieving 25-43% porosity. A carbonate mixture was prepared by mixing and grinding $LiCO_3$, Na_2CO_3 and K_2CO_3 powders and then infiltrated into the pores of the ceramic support. The infiltration of the molten carbonates is driven by the capillary force and the maximum filling rate achieved was 95%.

LIFE GreenYourRoute Platform

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Keywords: GreenYourRoute; LIFE; Logistics Platform; Emissions; Vehicle Routing Problem (VRP); Travelling Salesman Problem (TSP); Last Mile Delivery; Transportation Planning

LIFE GreenYourRoute is an innovative logistics platform for last mile delivery of goods in urban environments developed within a multidisciplinary approach of environmental engineering, computer science and operation research. The aim of LIFE GreenYourRoute project is to demonstrate an innovative, smart, and integrated green vehicle routing platform (i.e. an intelligent transportation planning and execution system) for last mile delivery. It includes a set of tools and services that promote eco-efficient sustainable freight transport operations in urban regions, via environmental-friendly vehicle routing decisions. At the same time, it addresses driving eco-requirements as well as operational cost efficiency through an innovative environmental assessment approach. GreenYourRoute Platform consists of a web application, a mobile application, and an optimization algorithm. The web application is separated in three main sections. The Planning section is the core of the creation of the daily plan with different characteristics and requirements. Each demonstrator uploads the daily orders, selecting the available vehicles and with three different methods can produce and upload the daily routes to the drivers. The three methods of the creation of the daily routes are: manually (by assigning orders to vehicles, semi-automatic (with pre-assignments and optimization algorithm) and automatic (with the optimization algorithm). With the previous methods the user has the freedom to create a manage the daily plan with multiple ways and methods provided by the functionalities of the web application. The Live section is the core of the monitoring of the daily plan. The user can monitor the progress of the daily routes in real time, add new orders to the plan and make changes and modification to the daily routes. The Settings section is the core of the stored data and requirements of each demonstrator. In the settings section the user can add, edit, and delete the main entities that are used for the creation of the daily plan (like customers, vehicles, drivers etc.). With the Mobile application provided by GreenYourRoute platform the drivers have access to the data of the daily routes. The mobile application with a friendly user interface displays the orders of the route and the driver can change the status of each order. In the web and mobile application, the emissions of each trip displayed. The emissions types are Fuel Consumption (FC), Carbon Dioxide (CO_2), Methane (CH_4), Carbon monoxide (CO), Nitrous Dioxide (N_2O), Ammonia (NH_3), Nitrogen Oxides (NO_x), Particulate Matter (PM), Volatile Organic Compound (VOC) and Sulfur Dioxide (SO_2). All the emissions are calculated by the Emission Calculator Tool of the GreenYourRoute Platform. The optimization algorithm of GreenYourRoute platform can produce a daily plan that meets all the different characteristics and requirements of each demonstrator. The algorithm takes under consideration all the static parameters of each demonstrator and the dynamic parameters of the daily data (orders, vehicles etc.) and with a dynamic process (linear programming with different steps of optimization like TSP, VRP etc.) calculates and produces an optimal daily plan.

Adsorption of Propylene Glycol in Aqueous Solutions on Activated Carbon: Kinetics and Fixed Bed Experiments

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Keywords: Adsorption; Activated Carbon; Propylene Glycol; Kinetics; Fixed Bed

Propylene glycol (PG) is an increasing demanded compound due to its antifreeze properties, applications in food and pharmaceutical industry and as raw material for unsaturated polyester resins manufacture [1]. Its production by catalytic pressure aqueous processing of glycerol is being investigated [2, 3]. The production of PG from glycerol has two main advantages. First, glycerol is a by-product of biodiesel manufacturing and its use can improve the economics of biodiesel production and avoid its accumulation. Second, glycerol is a renewable source in the bio-refinery strategy that competes with the oil source production.[4, 5]. Separation from the exit stream is critical due to compound's high dilution, inferring a prohibitive quantity of energy consumption if distillation is used. Due to all this, adsorption by Norit GAC 1240 W activated carbon is studied as a sustainable separation process. Batch and fixed adsorption experiments were performed as a first approximation to the development of this separation process. Batch experiments have the purpose of stablishing the kinetic adsorption data and the adsorption capacity of the sorbent. Batch experiments were conducted in 50 mL beakers with PG at concentrations of 10, 50 or 100 g/L. Activated carbon previously dried was added to the mixture and stirred using an orbital shaker at 160 rpm. Solutions were filtered and analysed in a Total Organic Carbon Analyser (TOC) at different times in order to have a good resolution in the results. Fixed bed experiments employ the kinetic data and are a previous step to implement the separation process in a pilot scale. Omnifit EZ Chromatography Column and Waters 515 HPLC pump were used to perform fixed bed experiments. The column was filled with activated carbon previously dried and feed concentration, bed height and flow rate were combined to study each parameter influence in the adsorption process. Finally, samples of 2 mL were gathered to be analysed in TOC, obtaining the breakthrough curve. Kinetic data obtained were evaluated by pseudo-second order model, Weber-Morris intraparticle diffusion model, and linear driving force model [6-8] and fixed bed data was fitted by Bohart-Adams model, Thomas model and Yoon-Nelson model [9-11]. As a result, pseudo-second order model was found as the model which better fits the experimental kinetic data, obtaining that, as initial concentration is raised, diffusion model and linear driving force are less accurate with the experimental points, meanwhile pseudo-second order model keeps a R^2 value higher than 0.99. However, it was also found that Weber-Morris intraparticle diffusion model, and linear driving force model had also

a good R^2 value at 10 g/L implying that despite PG adsorption is meant to be controlled by adsorption reaction, both film and intraparticle diffusion have their influence at low concentrations.

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Evaporation Heat Transfer Characteristics of R600a in Micro-Fin Tube

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Keywords: R600a; Heat Transfer Coefficient; Micro-Fin Tube

Although HFC refrigerants have zero ozone depletion potential (ODP), they have been classified as high-GWP refrigerants. The Kigali amendment states the phase-out of the production as well as the use of HFC refrigerants. In response to the regulation, R600a with low GWP and high thermal conductivity, has been paid attention by many researchers and manufacturers recently as a next-generation refrigerant to replace HFC refrigerants. Micro-fin tubes have been widely used in small refrigeration systems owing to their high heat transfer performance. Although many recent studies have investigated the evaporation heat transfer characteristics using R600a, most studies focused on high mass velocities and high saturation temperatures. Since the main application of R600a is a refrigeration systems, heat transfer characteristics under low evaporating temperature and low mass velocities should be studied. The objective of this study is to investigate the evaporation heat transfer characteristics of R600a with low mass velocity and low saturation temperature conditions inside a micro-fin tube at various saturation temperatures, mass velocities, equivalent Reynolds numbers, and heat fluxes. The experimental conditions were controlled by varying refrigerant charge, the opening of the needle valve, compressor frequency, heater power, pump frequency, and temperature of the water chiller. As a result of the experiment, the heat transfer coefficient and pressure drop increased with an increase in the equivalent Reynolds number and mass velocity owing to the intensified turbulence. The pressure drop decreased with a decrease in a saturation temperature because the liquid-gas velocity difference increased as a saturation temperature decreased. In addition, the heat transfer coefficient decreased with a decrease in the saturation temperature owing to the increased bubble departure diameter caused by the increased surface tension. This study provides a critical investigation on the heat transfer and pressure drop characteristics of R600a under a low evaporating temperature and mass velocity. Thus, the result of this study can be used in designing heat exchangers with tubes for refrigeration applications using R600a with low GWP.

Industrial Wastewater Treatment - Trends and Perspectives

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Keywords: Wastewater Treatment; Industry; Zero Liquid Discharge; Recycling; Secondary Raw Materials; Evaporation; Waste Heat

Water, energy, raw materials – key elements for every industrial activity. However, they are not available in unlimited amounts and the savings are discussed worldwide. Besides, there are negative environmental impacts related to their massive use due to increasing industrial production. This forces governments to motivate industry to implement saving measures and industry might by motivated by increasing cost of either water or energy or raw materials.
Industrial wastewater treatment may be considered as a contributor to recovery of water with sometimes with benefit of raw materials recovery. Moreover, depending on the treatment process, it can utilize frequently present low potential waste heat, which further increases efficiency of the primary energy source. Recently, the concept of zero liquid discharge (ZLD), or alternatively minimum liquid discharge (MLD), was introduced. The primary goal is waste reduction; however, recovery of water and the other positive impacts are not less important. It basically consists of three steps: pre-treatment (chemical and mechanical treatment), concentration (split into clean water and concentrated wastewater by filtration) and final treatment of concentrated wastewater (usually by evaporation and crystallization).
High investment cost and sometimes also operation cost of ZLD/MLD technology prevents it from more frequent application. The other reason might be lower awareness of the technologies between potential users. The objective of researchers should be an improvement of the individual steps as well as the whole process towards lower investment and/or operational costs. Moreover, optimal integration into the existing primary process is also very important. Some recent examples of ZLD/MLD technologies application in biogas plants, industrial laundries and wineries, which the authors have been dealing with, will be introduced.
Water is valuable, and water management in plants with high consumption should pay more attention. It can be positive in terms environment but also in terms of cost if designed and integrated properly. The presented examples demonstrate that there is a great potential for application of ZLD/MLD technologies to maximize water use efficiency and possibly raw materials recovery and waste heat utilization."

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Processing of Digestate from Biogas Plants

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Keywords: Biogas Plants; Liquid Digestate; Vacuum Evaporation; Ammonia Recovery; Anaerobic Digestion

Following significant financial incentives in European countries, biogas plants have become a widespread technology for biomass conversion and electricity generation. Approx. 18 thousand plants are currently running in the EU with a total installed capacity of over 10 GW. Despite the undeniable advantages of this technology, there are still several issues that need to be addressed. One of them is the inefficient use of the heat produced during the cogeneration process. Usually, only 20-40% of the heat produced is used. The main reasons for this situation are the lack of appropriate technologies and the low-potential nature of the waste heat (around 90°C).
Another problem is related to the treatment and use of wastewater (so-called digestate or fermentation residues). Digestate is a by-product of anaerobic fermentation of biomass and is particularly rich in nutrients such as nitrogen, potassium, or phosphorus. It is therefore mainly used as a natural fertilizer. However, the nutrient concentration is relatively low as the water content of the digestate ranges from 88 to 98 %. Since the production of digestate is significant, typically around 15 000 m3 per MW of installed capacity, plant operators have to face high costs for the storage and transport of this wastewater. For this reason, suitable technologies are being sought that can reduce the water content of the digestate and thus reduce its volume. Reducing the volume of the fermentation residues can have many economic and environmental benefits. These include a reduction in the need for storage space, fuel savings during digestate transportation, fewer passes of agricultural machinery over farmland, elimination of tanker passes through populated areas, noise reduction, reduced emissions, water savings for irrigation or other technical uses, minimization of nitrogen losses or meeting legislative requirements, in particular the nitrate directive.
The present study focuses on addressing both - waste heat recovery and digestate thickening - using vacuum evaporation as the main treatment technology. Vacuum evaporators are robust and reliable devices using low-potential thermal energy as the main energy source. The output of the evaporator is thickened fertilizer and ammonia water that does not meet the requirements for discharge to surface water. For this reason, it is necessary to extend the evaporators with other technologies such as stripping, membranes, or acid scrubbers. The present work summarizes the latest findings in this field, both technical and economic. It is based on experience from biogas plant operation and experiments on a prototype thickening plant.

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Impact of Seismicity to the Construction Cost of the Load-Bearing Structure of a 5-Storey R/C Building and Resulting Emissions

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Keywords: Construction Cost; Seismicity; Reinforced Concrete; Emissions

The present study deals with the analysis, dimensioning and estimation of the construction cost of a five-storey reinforced concrete building constructed in three different seismic hazard zones. The ground plan of the building studied is a conventional floor plan with solid reinforced concrete slabs. The cross-sections of the structural members remain stable, except for the columns whose cross-sections are reduced in height. The simulation of the load-bearing structure is performed with the SAP2000 software with linear elements. The modal response spectrum analysis is selected for the seismic analysis, while the behavior factor q is calculated according to EC8. The building dimensioning has taken place according to the EC2 and EC8 provisions for the ground floor for all three zones of seismic hazard provided for the area of Greece. After the analysis and dimensioning of structural components, the concrete and reinforcement steel measurements for the ground floor for each seismic zone take place. The aim of this research is to demonstrate how much the construction cost of the load-bearing structure of a reinforced concrete building is affected by the seismicity of the area. Useful conclusions arise from the comparison of the material measurement results for the three different seismic zones regarding the construction cost, as well as the emissions produced for the manufacturing of the load-bearing structure.

Comparative Study Determining the Characteristic Elements of a Support Retaining System Anchored on the Top, in a Deep Trench for Buried Energy Pipelines, with a Vertical Excavation Front

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Keywords: Deep Excavation; Underground Network; Pile Anchored Retaining Wall; Energy Pipelines

The object of the present paper is to determine the minimum support requirements provided for the safe execution of trench excavation works for underground network receptacles. This term is used to define the open excavations, which are carried out in order for underground networks to be installed or constructed, and which are classified in terms of place of execution and soil categories.
This paper focuses on the study of the method of support in excavations carried out in earthy soils and in particular in places where the passage of the pipeline requires deep excavations of vertical front. In these cases, for reasons of safety of both the personnel and the equipment, it is necessary to support the vertical excavation fronts, even when the analyses indicate their stability.
In this context, and in order to avoid the aforementioned consequences, before the start of the excavation and at its limit, the formation of vertical support structures is required, which are commonly known as "retaining bulkheads". The basic criteria for selecting the type of the support system are soil characteristics, local conditions (surface load, groundwater table) and finally, the lifetime of the trench.
Based on the above, the objective of the study is to investigate the temporary support of vertical fronts of depth trenches about 10 m, the excavation of which is carried out on earthy soil. The study is based on the implementation of the limit equilibrium method, which is applied according to the provisions - guidelines set out in Eurocode 7 (EN 1997).
The study investigates the distribution of earth pressures in an anchored retaining structure of a deep excavation by extracting the main design parameters of similar systems. The aim is to select the type of the support system depending on the soil properties (c, γ, φ and E) and local conditions, as a prerequisite for

safe and rational design. More precisely, the selection of the minimum required support system is controlled through the application of a system consisting of metal beams (Soldier Pile Wall), while in the end of the project useful conclusions are drawn.

Flood Inundation Mapping using 1D/2D Numerical Model. A Case Study of Flood Event in Greece

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Keywords: 1D/2D River Model; Hydrological/Hydraulic Modeling; Flood Inundation Mapping

Floods are amongst the greatest natural hazards in the world related to natural resources environmental problems, social and economic damages. In the last decade, many flood events have been observed and recorded in Greece, which have had a direct effect on the natural and anthropogenic environment. Therefore, the study and evaluation of streams' hydraulic behaviour is necessary for flood risk assessment and management in order to identify flood prone areas and produce effective flood management strategies. The primary topic of a flood risk management system is inundation mapping from numerical modeling results on inundation patterns using hydrodynamic models.
In the current research work hydrological simulation of a "flash" flood event, due to torrential overflow, occurred in November 2017 in the southwestern slits of Mt. Ossa, was performed for water discharge hydrograph estimation using available rainfall data from neighboring weather station. The studied watershed area delimits in the north-eastern section of Thessaly region and it is a part of Pinios river basin located at the entrance of Tempi Valley within administrative limits of Larissa's Prefecture. Effective rainfall and parameters related to land coverage and slope were calculated. The aim of this study is to generate flood inundation maps in a flood affected area, under steady and unsteady flow conditions, as an extension of the European Directive 2007/60/EC on the assessment and management of flood risks. Moreover, the predictive ability of one-dimensional and two-dimensional hydraulic numerical models for an accurate simulation of inundation area and river water surface elevation is investigated. Firstly, with the HEC-RAS 1D model a numerical simulation of water surface variation along the natural river, under steady flow conditions, for a return period of 100-year flood event, was performed. In addition, HEC-RAS 2D unsteady numerical simulation was applied for the specific flood occurrence event. Numerical results of one–dimensional and two–dimensional numerical models were adequately compared with available field measurements providing the reliability of the current methodology. Comparisons show that the two–dimensional simulation of water depth variability along and across the flow path is a more accurate procedure for the flood extend estimation.

Energy Production through Water Supply Network. The case of Larissa City, Greece

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Keywords: Water Pipelines; Energy Production; Energy Saving; Micro-hydropower Plants; Power Generators, Sustainable Infrastructures

The energy production becomes more and more challenging nowadays, since more sustainable and effective techniques are adopted, compared to past ones. Earth climate is facing, on accelerated rate basis, severe phenomena, requiring more demanding and innovative energy harvesting methods, along with reduced environmental impact.

Hydropower generation systems are of the most common renewable energy systems in the world, based on the same concept of solar panels and windmills, meaning that such technologies take advantage of resources that already exist in abundance. The essential concept stands for installing water turbines in main pipes of the water network. The flowing water into those pipes could generate energy since it continuously operates, 24 hours per day, all over the year.

The main purpose of this project is to generate power from the outer water pipe network of the city of Larissa, Greece, by harvesting energy that otherwise would be lost. The flow of water in combination with altitude difference, results in increasing pressure in the pipe network. The City of Larissa is supplied water from three main water reservoirs, in “Mezourlo”, “Agia Paraskevi” and one underground tank, in the surrounding area of water supply and local sewerage company. The annual consumption of water of Larissa reaches to the amount of 15 million cubic meters.

Many types of water turbines, such as “Kaplan”, “Francis” and “Lucid” (lift type), take advantage of the excessive head pressure and produce energy through a generator. Such a procedure is applicable in a wide range of head and flow conditions. The main principle of this process is based on the transformation of mechanical energy due to water flow into electrical energy. The generated power is being driven into the

electric network or even stored in batteries for later use. The whole activity not only leads to a financial benefit for the company, but also reduces the operational and functional energy footprint. Such actions could further be improved after being combined with solar and wind energy harvesting, substitution of old lighting systems by led technology, installation of energy management systems, etc.

In our project, the annual water consumption of Larissa City for past years is taken under consideration, in order to theoretically install the three prementioned types of turbines, in pipes with diameter over 500 mm. Those turbines, will be positioned between reservoirs and the city network and they will exploit the pressure as well as the velocity of water. The produced energy is over anticipation and is going to be used to cover electricity needs of company's facilities. At last, an economic analysis provides a clear view of the benefits of such energy production method.

In conclusion, energy production from water supply network, proves to be an effective solution for covering electricity needs of various public services, contributing in their financial status, as well as it contributes for the abatement of carbon footprint.

A Consistent Approach on the Optimization of the Existing Forms of Energy

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Keywords: Energy Sources; Energy Systems; Infrastructure Projects; Research Questionnaires

The purpose of this work is to compile proposals arising from research through questionnaires, in which undergraduate students of the Civil Engineering Department of Technological Education (T.E.) in Larissa took part, along with postgraduate students of the MSc Postgraduate Program "Modern Technologies of Environmental Management Projects" organized by the General Department of the University of Thessaly, Professors of the University of Thessaly, Academic Scholars and Institutions that deal with the management and utilization of energy, with the ultimate goal of highlighting the optimal choice of energy supply in both homes and public buildings, as well as large infrastructure projects.
The energy upgrade of buildings and the green transition is one of the largest projects currently being implemented in Greece. At the same time, the development of island interconnections is investigated, which is essentially the passage for the transition of renewable energy to the Greek mainland or vice versa, the creation of storage units, the treatment of poverty in energy, the undergrounding of networks, etc.
The strategy of the present research concerns the design of the questionnaire according to the latest developments in the field of energy upgrading in Greece for both the mainland and the island part of the Region of Thessaly. At the same time, the questionnaires emphasize renewable forms of energy as they are characterized by Directive 2009/28 / EC (wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydroelectric, biomass, photovoltaic, etc.). In fact, renewable energy sources are flexible applications that can produce energy commensurate with the needs of the local population, eliminating the need for huge power plants (primarily for the countryside) but also for energy transport over long distances. For the compiling of the questionnaires, the possibilities of the supplied energy items, their efficiency, the means of production as well as the way of their transportation were considered as variables. The questionnaires used various types of questions such as open-ended completion and development questions as well as closed multiple-choice, hierarchical and ranking questions.

The responses were evaluated, and useful conclusions were drawn which could contribute positively to a better utilization of the provided forms of energy as well as to an improvement of the efficiency during the end use with a main aim to reduce the environmental imprint. The majority of respondents are more positive about solar thermal, photovoltaic systems and wind energy.

Finally, based on the present research and its results, it is proposed to conduct a broader research by all scientific bodies involved in energy management, so that the new emerged data could be a start for a comparative study in all the Regional Departments of the Country.

Evaluation of Static Slope Stability Methods, Regarding to Areas with Buried Gas Pipelines, Sewerage and Cable Networks

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Keywords: Electrical Cable Network; Sewerage Pipeline Network; Slope Stability; Wide-Scale Infrastructures Stability Assessment; Energy Pipeline Failure; Estimation Methodologies

A large number of sewerage and underground cable networks, natural gas pipelines, pass through susceptible areas on a global scale, meaning that they are vulnerable to slope instability. Such occurrences of ground slides, may lead to soil rupture, where the aforementioned networks could be located, especially on areas that are subjected to wide-scale substructure projects, including foundations of buildings, highways, railways, even in large-scale infrastructures such as bridges and dams.
Moreover, the landslides, could produce ground displacement leading to critical situation for power supply and urban waste water networks, resulting in energy loss and complete failure, in case the factor of safety becomes lower than 1. Landslides cause major natural impacts and long periods of soil chemistry disturbance. Failure of such networks is a common phenomenon during ground landslides. In addition, landslide-related incidents often result in long periods of operational stoppage.
Referring to energy cable networks or gas pipelines that are passing through high altitude regions and waste water pipes that are founded in urban and suburban areas, statistics show that landslides are the main cause of spoilage of the above networks (e.g. Sweeney et al., 2005; Marinos et al., 2016).
Designing of great construction projects in urban and suburban areas focused on evading locations that are most susceptible to undergo geohazards (described as ground movements that could arise from slope failure during various situations, such as presence of aquifer horizon, porosity or shaking).
This approach has been generally successful when there are limited restrictions on selecting a pipeline route. Avoiding potential geohazards is becoming increasingly difficult because of the inability to obtain landowner agreements, the lack of space in common utility corridors, environmental restrictions, incompatibility with existing land use, and/or public opposition. In route corridors where geohazards cannot be avoided, the potential risks associated with these hazards must be managed (Honegger et al., 2010).
As conclusion from the pre-mentioned, it is of great importance to evaluate the static slope stability. The question arises is: which is the optimal methodology for such an estimation? In this study, a multi-criteria

assessment of three widely applicable limit equilibrium methodologies (LEM), known as “Fellenius”, “Bishop” and “Taylor” and two numerical methods, the Finite Element Method (FEM) and the Finite Difference Method (FDM) with strength reduction, is presented. The criteria to evaluate these methods stand for: a) accuracy, b) ease of application, c) range of application and d) completeness. The interesting findings of this research are presented herein, implementing the Analytical Hierarchy Process (AHP) in the frame of the assessment methodology proposed.

Experimental and Analytical Investigation of the tensile Strain Impact on the Buckling of Highly-Reinforced Structural Walls and their Sustainable Design

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Keywords: Buckling; Seismic Walls; Tensile Strain; Highly-Reinforced; Sustainable

In the context of the present work, the influence of the degree of tension on the phenomenon of transverse instability of reinforced concrete walls is examined. The present investigation is both experimental and analytical and consists of 4 test specimens. These specimens simulate the extreme boundary edges of structural walls. All columns simulate only the extreme reinforced areas of the walls, in order to study the basic mechanism of the phenomenon. The detailing of the specimens consists of 6 rebars with a diameter of 8 mm for each bar. The geometric dimensions are the same for all specimens. What differentiates the specimens from each other is the degree of tension they have sustained. More specifically, the tensile degrees used are 10‰, 20‰, 30‰ and 50‰. The loading stages of each specimen for all specimens are as follows: (a) Uniaxial central tensile loading on each test specimen; (b) Uniaxial central compression loading on each specimen till its failure due to buckling or due to an excess of its cross-section compressive strength. Extreme tensile strengths are also used, e.g., 30‰ and 50‰, in order to take into account, the cases of extreme seismic excitations. The experimental study is followed by the analytical investigation of these 4 specimens using appropriate finite element software. Useful conclusions are drawn regarding the influence of the degree of elongation on the phenomenon of transverse buckling. These conclusions are substantiated both experimentally and analytically, as the results of the experiments are compared with the corresponding results of the analytical investigation. Moreover, some thoughts on a more sustainable design of R/C seismic walls are stated.

An Empirical Analysis of Renewable and Fossil Energy Investment Decisions Based on Policy Instruments: A Global Study with Mathematical Models

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Keywords: Sustainable Development; Tax On Fossil Energy; Subsidy On Renewable Energy

Growth in population and economy can be attributed as one of the major factors for the steady increase in the amount of consumption, which in turn intensifies the energy demand. Most of the energy demands (about 80%) are met from fossil energy. However, with the limited reserves of the fossil energy, its continuous use will lead to economic crises as it can be observed with the fluctuations in oil prices. Beside the economic impact, fossil energy is harmful to the environment by degrading the land, and by polluting the air and water, which leads to the global warming. Hence, providing sufficient, safe, affordable, and sustainable energy has become essential for economic growth and human development. A sustainable economic development can be achieved by using renewable energy sources instead of fossil energy. Even though the high cost to be incurred due to the damages caused by fossil energy to economic, environmental, and human health is known, the high cost of sustainable energy in the short run appears to be a major obstacle to switch to renewable energy sources in order to protect the future of the world. All these issues have been in the agenda of different organizations in the past 50 years and the Executive Council of the United Nations Environment Program (UNEP) first discussed the subject of ozone depletion to secure the future of the world in 1976. In this context, with the 1987, 1990, 1992, 1997, 1999 and 2015 Paris Agreement, it was aimed for countries to make policy changes in order to reduce their carbon emissions. This agreement has required the countries to make long-term analysis and the necessary policies to reduce their carbon emissions. In this study, a mathematical model based on renewable and fossil energy cost analysis has been developed and the energy expenditure decisions of countries are calculated by using linear programming. 147 countries and country communities for the period of 1997-2014 were included in the analysis using the World Bank data set. The pump price for diesel fuel is used as the fossil energy price index. As the renewable price index, a single real renewable price index at the world level is derived from the fossil energy price. The mathematical model has been run using different parameter sets to create a full factorial experimental design. Among the parameter sets, the ones that best describe the reality were selected using the grid search method and used for policy analysis. Policy analyses were made using selected parameter sets with another mathematical model we developed. In this context, three policies have been examined, which are changing decision-making periods, taxing fossil energy, and promoting renewable energy with subsidies. The scenarios where combinations of these policies are applied together and alone are analyzed with the regression analysis and the effects of the policies are evaluated. According to the results obtained, the transition of countries from short-term planning to long-term planning and the application of tax on fossil energy prices significantly reduce fossil energy consumption and investment.

EV Charge Station Locating Problem-Case study: ITU Campus

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Keywords: Electric Vehicle; Electric Vehicle Charging Station; Set Covering

Improvements in clean energy use individual vehicles are widespread with the awareness of carbon emission mitigation. Yet, the increase in electrical vehicles create the problem charge station locations. There is a considerable amount of research on the subject based on finding stations in accessible places for drivers to charge their vehicles. This study aims to handle the locations in an existing campus, hence, the charge station layout plan is focused on the available parking capacities and the number of individual drivers to be served. It was identified how the optimal choice of electrical vehicle charge station (EVCS) location was affected by different models and parameters in a campus. Three different coverage models have been applied using the case campus data. The optimal locations are selected with respect to the demand of potential electrical vehicle users and spatial availability. The solution of the problem has been provided with the data created by using geographic information systems and voronoi diagram. The results from the models have been compared, and the optimum station locations are determined.

A Multi-Objective Mathematical Model for the Electric Vehicle Charging Station Placement Problem

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Keywords: Electrical Vehicle; Charging Station; Sustainability; Multiobjective Optimization; Weighted Sum Scalarization Method; Smart City

Using alternative energy sources instead of fossil fuels is critical for the future of our planet in terms of tackling global warming as it reduces our carbon emissions. Energy technologies have advanced to the stage where electrically powered vehicles are a viable alternative, and this presents us with an opportunity to have a transport sector that runs on alternative energy sources. As the popularity of electric vehicle (EV) technology continues to develop rapidly, so does the demand for charging stations, which are expected to be the main source of energy for electric vehicles in smart cities. An ideal charging network of stations would facilitate easy access for drivers by ensuring that there is always a station nearby, and do that with the minimum number of stations to reduce infrastructure costs. Motivated by striking a balance between these two, we propose a novel multi-objective model for the EV charging station placement problem (EVCSPP) under a renewed constraint of a network that aims to make it easy for drivers to reach a station from anywhere in a city within a reasonable distance. We aim to develop a mathematical model to decide the location of charging stations with multi-objectives: minimizing the number (cost) of charging stations and minimizing the distance (D) between opened stations and between the opened stations and the regions. These two objectives are conflicting because minimizing D causes an increase in the number of opened stations. This structure of multi-objective and network constraints lead to the addition of new decision variables to the model. We solve the model using the weighted sum scalarization method with the normalization of the objective functions. Furthermore, we consider some extra constraints: the minimum distance between two charging stations to be opened (m) and the maximum number of regions that each station can serve (M). We apply the model to Eskisehir in northwestern Turkey and demonstrate and discuss the results which show effective and practicality of the model. We then construct a sensitivity analysis with varying the weights and the values of (m,M). After the sensitivity analysis, we show that the maximum 16 stations and the minimum 4 stations are needed to construct a network within the distance 16.9 km and 22.8 km, respectively.

Implementation of a Forest Fire Propagation Model

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Keywords: Forest Fire; Mathematical Model; Sensitivity Analysis

This work focuses on the study and implementation of a forest fire propagation model (Rothermel, 1972) through mathematical equations that describe the phenomenon. These phenomena of natural origin or human negligence cause, occur mainly during the summer season, and generates extensive forest destruction throughout the planet, causing both material and human damage, due to their unpredictability, speed, and difficulty of control. Portugal is no exception and every year, buffeted by numerous forest fires with serious social, environmental, and economic consequences. However, there does not seem to be any success in the measures taken in relation to the prevention and combat of forest fires, since these are constantly occurring.

Consequently, forest fires became a major research subject among national and international researchers. Different simulation models have been developed in an effort to prevent these fires. Nevertheless, fire propagation models are until now a challenge due to the complexity of physical models, the high computational requirements, and the difficulty to define the input parameters.

The choice of this model in question is related to the fact that it is one of the pioneering models on the area under study, still serving today as a basis for the development of new models and as well for the construction of some computer programs, such as BEHAVE, SPREAD, FARSITE and FLAMMAP (simplified version of the FARSITE program).

In this way, this mathematical model was implemented to understand the influence on the fight against forest fires and understand the interference of the different key parameters (fuel, terrain topology, and weather conditions) that influence the spread of fire and how it is fought by the different intervention teams, since some of these parameters have a higher sensitivity power, considering them as the critical parameters of the model. Among the different parameters, the wind velocity was the main parameter influencing the radiation intensity of the fire and forest fire propagation.

Human-Robot Synergy in Agriculture: A Real-World Automated System for Driving Operations Efficiency and Rural Welfare

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Keywords: Human-Robot Synergy; Sustainable Agriculture; Safe Human-Robot Interaction; Information-Based Operations Planning

Global risks, regional catastrophic events and pertinent policy responses (e.g., pandemics and mobility restrictions) highlight that resilience in farming operations is pivotal for ensuring stability in agri-food supply chains whilst ensuring downstream food security and promoting upstream rural welfare. In this regard, Agriculture 4.0 and particularly human-robot synergistic systems are emerging as a viable technological solution to support effort- and time-consuming operations in horticulture such as harvesting and handling of crops. In this context, this research develops a knowledge-based human-robot synergistic system for assisting out-door harvesting operations to achieve an overall improved efficiency in high-value crops logistics. More specifically, this research is performed along two axes with the aim: (i) to improve human-machine synergy by introducing augmentation technologies to support machine's situation awareness including workers' activities; and (ii) to increase system efficiency by optimizing information-based operations planning. In pragmatic terms, the piloted automated system focuses on the scenario where a robot follows and properly identifies human activities related to a particular task (e.g., picking fruits, lifting a crate, placing a crate onto the robot), and, subsequently, transports the crate for the out-of-the orchard removal of the collected crops. To achieve these research outcomes, an inter- and multi-disciplinary approach is deployed with research areas such as engineering management, software engineering and information engineering to provide the technological framework while other such as agricultural and business domains to provide the operational framework of the system. The dynamic version of the above-mentioned approach is developed as a complete robotic fleet logistics solution for the co-ordination between the service units of the fleet and between the fleet and the workers. This approach contrasts with current research, where the planning as well as the information obtained from the recording/monitoring systems can in most cases be considered isolated, and not as integrated in a whole system. We envision the generation of a paradigm of human-robot logistics synergy that will be applicable in both operational environments of the out-door in-field harvesting and handling, and the in-door prior to processing storage operations for high value crops.

EFRI Model: Finding the Optimum Free Electricity Amount

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Keywords: Energy Poverty; Energy Justice; Electricity Tariff; RECS; EFRI Simulation Model

Electricity has become a basic need for almost every individual considering its effect on health, security, and even education. Many low-income households suffer from energy insecurities, limit their basic needs to afford energy bills, and live in unhealthy conditions. Although social tariffs and energy assistance programs alleviate these issues to a certain extent, many households still suffer from energy poverty. Furthermore, due to the interdependent nature of the electricity market, the excess electricity usage of some households increases the electricity unit prices and exacerbates the energy poverty issues. As a solution, a certain amount of residential electricity can be provided for free to every household. The examples of Flanders in Belgium, and Delhi in India are the first implementations of a free electricity policy. On the other hand, it is complicated to determine the optimum amount of free electricity considering many socio-economic parameters such as energy consumption habits, electricity prices, number of residents, and income levels. This study aims to answer the question: "What would be the optimum residential free electricity amount which would alleviate the energy poverty issues most?". The "Energy as a Fundamental Right (EFRI)" simulation model is developed to answer this question. Six indicators are considered for measuring energy poverty: average ratio in income of all households, average ratio in income of low-income households, median ratio in income of all households, median ratio in income of low-income households, number of energy-poor households, number of energy-poor residents. The model is designed to be self-sufficient such that the residential unit price of electricity is increased to a certain level to compensate for the total free electricity amount. An equilibrium is established between the rising unit price of electricity, free electricity amount per person, and free electricity amount per household. The optimum free electricity amounts are determined by considering the selected energy poverty indicators. The EFRI simulation model is tested on the USA's 2015 Residential Energy Consumption (RECS) data. The optimum free electricity amounts are calculated for each census region and each simulation indicator. A detailed analysis of the Middle Atlantic region is provided with insights obtained from the simulation results.

Performance Comparison of Different Channel Types and Air Flow Rate for Vacuum Membrane Dehumidifiers

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Keywords: Vacuum Membrane Dehumidifier; Nafion Membrane; Serpentine Flow

In tropical/subtropical Asia, outside air relative humidity (%) mostly ranges from 80 to 90%. To meet the human comfort zone in air-conditioning, the indoor humidity control becomes increasingly important. The conventional dehumidification technology for air-conditioning system is to remove the humidity in the supply air by a cooling coil, which reduces the temperature below its dew point. The entire process would cause the water-condensation and consume significant energy resulting in the system inefficiency. Hence, the planar membrane dehumidifier has recently attracted considerable attention by separating water vapor from the humid air via the membrane. The driving force for moisture permeation stems from gradients in temperature, pressure, or concentration. The vacuum-based membrane dehumidifier (VMD) uses a pressure gradient to transfer the water vapor through the selective membrane which is an emerging technology for removing excessive moisture from the humid air. In the present study, the performance measurements including the air permeance (AP) with four commercial Nafion membranes, Nafion-211, 212, 115 and 117, and the effect on the flow channel, the single (1-S) flow, double (2-S) flow and triple serpentine (3-S) flow channel, were examined by the standard of ISO 15105-1. The results show that the air permeance of the level is sequentially Nafion-211, 212, 115 and 117. For the effect of serpentine flow field configurations, 3-S channel has the highest air permeance because of the complex channel pattern resulting in more sufficient time for the air movement through the membranes. Based on the measured data, the suitable membrane can be chosen for further design and optimization in the planar membrane dehumidifier. Moreover, the dehumidification performance experiment of the VMD is conducted with indexes including dehumidification rate (DR), water flux (J), pressure loss (ΔP), pumping power (Ω) and coefficient of performance (COP). The experimental results reveal that the dehumidifier with 3-S channel presents the best performance with the longest retentive time in the dehumidifier.

Experimental Study of a Box-Type Solar Cooker using Jatropha Oil as a Sensible Heat Storage Material

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Keywords: Solar Cooker; Heat Storage; Solar Energy; Thermal Performance; Jatropha oil

Solar cookers are an interesting alternative to the use of woody biomass for cooking in Sahelian countries with high solar potential. However, the cookers are limited in their use due to the intermittence of solar energy. This paper presents the thermal performance of a box-type solar cooker using jatropha oil as a sensible heat storage material. The results highlight the ability of this cooker to overcome the weakening of solar radiation during operation. Also, the results show that the experienced cooker achieves better thermal performance compared to the cooker without storage; the maximum power obtained is 177.8 W and the maximum thermal efficiency is 77.87 %. In addition, a socio-economic analysis of the use of this cooker shows that it can provide nearly 67% of annual household cooking energy needs. This would reduce wood consumption by 615 kg per household per year.

Energy and Comfort in Buildings

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Keywords: Energy; Comfort; Green Buildings; Occupant behaviors; Buildings

In a world ripped apart by human activities, now more than ever, it is necessary to move into a sustainable green society. This is not something that is achievable from day to night and although transition is being made there are several aspects which need to be improved, especially in green buildings since they are the most sustainable, to increase occupant overall well-being and public opinion.
To understand how today's buildings are performing in different points of the globe and what strategies can be used to help reducing building footprint while improving comfort, a systematic review was conducted according to the guidelines of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). ScienceDirect and Scopus were used in the literature search which was completed on the 9th of February 2021. Twenty-five articles were included. This data was structured in different categories. Green buildings, Buildings in different climates and Occupant Perception. Although occupant perception might seem a far less relevant topic it will be seen ahead that is as crucial as the building itself. The aim of this systematic review is to demonstrate how buildings are becoming greener, strategies that help making the transition and how occupants are perceiving change.
It was found that although green buildings reduce energy consumption and carbon footprint, often they neglect occupant comfort and health. Different strategies needed to be used in different climates in order to use the environment characteristics in human advantaged. Knowing the environment characteristics gives a crucial advantage in the designing phase as engineers can suit systems which are going to use the most out of the environmental conditions available. Lastly it was discovered that general standards on occupant comfort are very relative because of the innate characteristic of human adaptation. This fact makes occupant behaviours a topic that needs some more in-depth study as small things such as desk location can have huge impacts on how occupants perceive comfort.

A Load Scheduling Model for a Smart Public Building

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Keywords: Battery Storage; Cost; Linear Programming; Photovoltaic; Scheduling

The rapidly growing world energy consumption raised concerns about supply difficulties, spend limited resources, and side effects on the environment by global warming, climate change, and so on. Building energy consumption is responsible for a huge portion of energy consumption; thus not only environment-friendly electric production but also efficient electric utilization is essential. Solar power is an unlimited and trusted source of energy; consequently, photovoltaic panels and batteries have become popular in this sector. Currently, small-scale power demand can be responded to with affordable solar energy investments. The new energy storage systems improve the efficiency of electric usage generated using photovoltaic systems by overcoming the uncertainty. However, the complexity of managing the integrated systems is increasing, part of which can be solved by designing a power load schedule. In this study, a system with solar panels and lithium-ion batteries are designed to respond to the power demand of a university building by using a linear model. The main objective is to design load scheduling for a solar-battery integrated system with minimum cost by analyzing the energy consumption path of a public building. ITU Energy Institution building is selected as a case study that includes classrooms, administrative offices. The impact of the proposed schedule is investigated. Power consumption is simulated using eQuest. Homer software is used to simulate the power generation using photovoltaic and battery storage. After defining the demand and supply, the energy load schedule is constructed using a Linear Programming model to minimize the total costs. It is observed that the annual expenditure of ITU Energy Institute and carbon dioxide emission can be reduced by about 44.78% and 68.2% in order when PV panels are used alone, also a reduction by 45.46% and 70.76%, respectively, when integrated with the storage system. Therefore a reasonable scheduling plan with PV panels and batteries could raise the electric performance of an existing building.

Carbon supported Ultra-Low Pt (Pd x Pt y) Electrocatalysts Preparation, Characterization and H_2-PEMFC Performance

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Keywords: Low-Pt Electrocatalyst; Palladium-Platinum; Hydrogen Oxidation Reaction; Oxygen Reduction Reaction

Ongoing research on H_2-PEMFCs electrocatalysts has been focused on reducing Pt metal loading and increasing specific and mass activities. In the present work very low-platinum electrocatalysts, i.e., $Pd_{97}Pt_3$/C, $Pd_{98}Pt_2$/C, $Pd_{99}Pt_1$/C and pure Pd/C, are prepared and examined for the hydrogen oxidation reaction (HOR) by the rotating disk electrode technique. The electrocatalysts are prepared via a modified pulse-microwave assisted polyol method and are physicochemically characterized with the techniques of X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and electron backscattered electron diffraction (EBSD).

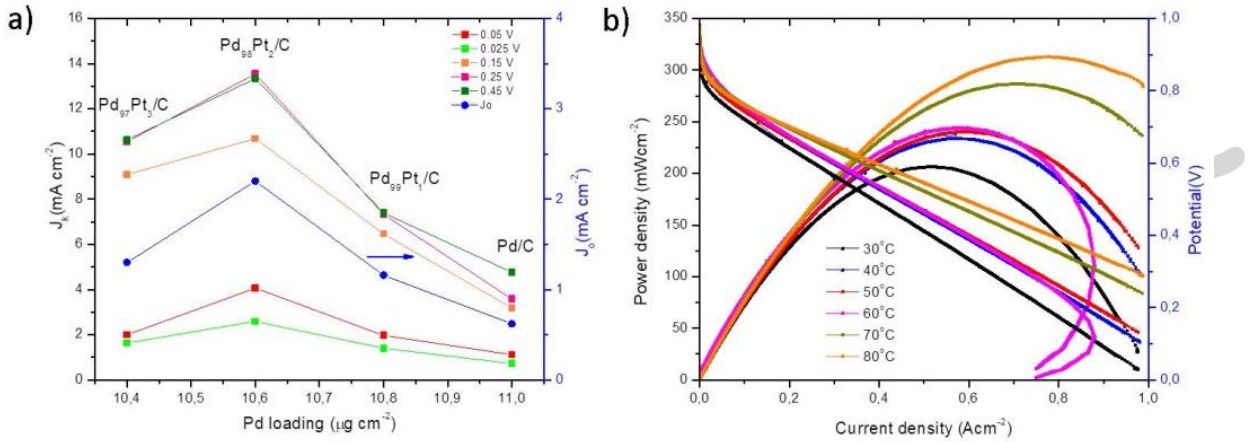

Figure 1. a) Dependence of exchange current density (J_0) and kinetic current density (J_k) on Pd loading and b) Comparison of polarization curves at different cell temperatures, ranging from 30-80 ^oC

According to the experimental results, all the as-prepared Pd-Pt bimetallic electrocatalysts exhibit much higher activity towards HOR than the pure Pd, presenting a volcano-type dependence on Pd loading. Among the investigated electrocatalysts, $Pd_{98}Pt_2$/C presents the highest electrocatalytic activity. It is found that the highest exchange current density (J_0) and kinetic current density (J_k) values are observed for the $Pd_{98}Pt_2$/C sample (Figure 1a). A single proton exchange membrane fuel cell fed with hydrogen (H_2-PEMFC) is

fabricated, employing the as-synthesized $Pd_{98}Pt_2/C$ as anode and a commercial Pt/C as cathode. The total anode Pt loading was only 657 μg_{Pt} cm^{-2}. The performance characteristic curves of the as-fabricated fuel cell are displayed in Figure 1b. A relatively high slope (resistance) for the potential-current curves is observed, which decreases with the temperature increase. It can also be seen that the observed peak power density (313 mW cm^{-2}) is among the most reported ones. Consequently, Pd can replace at the most percentage the platinum electrocatalyst.

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The Performance Improvement of PEMFC by applying Magnetic Field under Various Conditions

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Keywords: Polymer Electrolyte Membrane Fuel Cell (PEM Fuel Cell); Magnetic Field; Kelvin Force; Constant Voltage; Paramagnetic Material

The low catalytic activity on the cathode electrode and disproportionate gas supply are currently major problems in PEM fuel cells. One of the ways to solve these problems is using a magnetic field. Oxygen is affected by the Kelvin force in the magnetic field owing to its paramagnetic characteristics. Using this physical phenomenon, we can increase oxygen concentration near the catalyst layer and solve the unbalance supply of the oxygen. In this study, we analyze the performance improvement of the PEM fuel cell using the magnetic field in various conditions. Arranging neodymium magnets in various way, we created the various strength and direction conditions of magnetic fields. First, with the different magnetic field densities of 80 and 110 mT, the performance improvement of the PEM fuel cell was proportional to the magnetic-field density. This was because the Kelvin force was proportional to the magnetic-field density. Secondly, we conducted experiments with different magnetic field directions. The experiment was conducted in two cases when the direction of magnetic field and oxygen diffusion were the same or opposite. As a result, the effects of magnetic field direction on the performance improvements were insignificant. Regardless of the direction of the magnetic field, the performance of the PEM fuel cell was improved. The existence of the Kelvin Force made the oxygen slightly move, and the slight movement of the oxygen was sufficient to improve the concentration loss in the PEM fuel cell. Finally, we conducted constant voltage experiment. Through this experiment, we analyzed the tendency in the performance of the magnetic PEM fuel cell over time. We carried out a 0.7 V constant voltage experiment for 30 min with and without magnetic fields. The experiments showed the performance improvements in all 30 minutes regions when there was a magnetic field. However, over time, the performance improvement effect of the magnetic field gradually decreased. Owing to the water accumulation in the flow field as the experiment progressed, these residues interfered with the flow of oxygen, which reduced the performance improvement effect of the magnetic field.

Assessing Input Use Deficiencies using Data Envelopment Analysis (DEA) in Durum Wheat Production

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Keywords: Data Envelopment Analysis; DEA; Efficiency; Durum Wheat

Overpopulation and climate change formulated a context generating a series of challenges regarding food security and price stability. Durum wheat is one of the most cultivated cereals globally, thus ensuring wheat production while protecting cultivation from environmental conditions, remains a top priority issue for humanity. In the era of enhanced environmental protection and constant reduction of natural resources exploitation, quantification of excess use of inputs involved, is a top priority issue for achieving environmental and operational sustainability.
This study focuses on an operational and environmental analysis of 4 different agricultural cooperatives, producing durum wheat under the same production protocol in two different countries, Greece and Italy. The main target is to highlight input use efficiency differences among members of the same cooperatives. Cultivated area, seeds, agrochemicals (herbicides, fungicides, and insecticides), required energy (diesel and electricity) and final production have been taken into consideration as the main variables for this analysis. Moreover, environmental indicators of carbon, water and ecological footprint have been included as well. All variables have been calibrated under 13% of moisture content of the final product. The overall sample consists of 563 farms in both countries. Data Envelopment Analysis (DEA) has been applied, ranking all involved farms from 0 (for the worst practices) to 1 (for best practices), but also indicating excessive use of inputs, presented as slacks. It has to be stated that input-oriented approach has been used so as to minimize environmental impact, as well as to reduce capital intensity for durum wheat farmers. The mean efficiency scores were 0.646 and 0.693 respectively for Greece and Italy, indicating that there is 30-35% space for improvement among farmers of the same country. It has to be underlined that efficiency differences have been also observed between cooperatives operating in the same country, applying the same production protocol, meaning that further analysis is needed for clarifying the reasons leading to such inefficiencies. Concluding, durum wheat cultivation is strongly connected with food security globally, thus input use efficiency should be constantly monitored for achieving the maximum output with the least used resources, promoting by this way the 2nd Sustainable Development Goal (SDG) of zero hunger until 2030.

Current Progress on CO Tolerant Anode Electrocatalysts for H_2- PEMFCs

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Keywords: H_2-PEMFCs Degradation; CO Tolerant Electrocatalysts; H_2-PEMFCs Electrocatalysis; Pt-Based Electrocatalysts

One of the major drawbacks currently hindering the commercialization of hydrogen fed proton exchange membrane fuel cells (H_2 -PEMFCs) is their activity degradation in the presence of even trace amounts of carbon monoxide (CO) in the hydrogen fuel. The most promising strategy to overcome this issue, towards which the research community has focused on, is the development of highly CO-tolerant anode electrocatalysts. Conventionally, CO-tolerant electrocatalysts refer to combinations of Pt with other transition metals. It has been verified that the addition of another metal to Pt can alter its CO adsorption and oxidation properties, through the modification of its electronic structure and the formation of oxygenated species on the catalyst surface. Although in past decades several CO-tolerant electrocatalysts have been proposed, their sensitivity at high CO concentrations and their poor stability prevent their practical application. Recently, efforts are devoted on Pt-based electrocatalysts, including alloys, core-shell structures, Pt combinations with metal oxides, and conventional Pt electrocatalysts with modified surfaces. Additionally, the perspective of substituting conventional carbon black support with advanced carbonaceous materials or metal oxides and carbides is widely explored. In the current review, we provide a brief introduction to the fundamental aspects of CO tolerance, followed by a comprehensive presentation and thorough discussion of the recent strategies applied for enhancing the CO tolerance and stability of anode electrocatalysts. The aim is to set the progress made so far, distinguish the most promising state-of-the-art CO tolerant electrocatalysts, and identify the future challenges. The nature of our discussion has as an ulterior aim the provision of a fundamental understanding on the mechanisms and the physicochemical properties of the materials that are favorable for the enhancement of CO tolerance.

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A Systems Approach for the Integration of Renewable Energy in Key Industrial Sectors in the UAE

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Keywords: Renewable energies integration; cement industry; Aluminum industry; Optimization

Energy intensive industries contribute to about 25% of the CO_2 emissions globally. In the Emirate of Abu Dhabi, several energy intensive industries such as aluminum, steel, cement and petrochemicals contribute to about 15% of the total CO_2 emissions. The UAE have launched several initiatives to cut its emissions by 24% by 2030 compared with 2016 levels. In this project, we have investigated several energy intensive industries in the Emirate of Abu Dhabi, such as aluminum, steel and cement. We used a system approach to identify for each industry studied the manufacturing processes that contribute the most to the CO_2 emissions. We have then investigated the most efficient means to cut the CO_2 emissions. The results of two case studies are presented in this presentation.

The first one is related to cement industry. We have used linear programming to determine the optimal configuration for the integration of RE for a cement plant. The optimal configuration of renewable energies (RE) integration is determined for electricity supply, and heat supply to the pre-heating and the kiln processes in the cement production. The results show a reduction of the CO_2 emissions of about 15%, and a potential cost reduction of 8 million USD.

The second case presented is related to the steel industry. It proposes the integration of RE for the hydrogen production in the hydrogen direct reduction (HDR) process in the steel manufacturing. A linear programming is used to determine the optimal configuration of renewable energy and storage capacities. The key feature of the RE integration is the flexibility in the energy demand through hydrogen storage. The reduction of the CO_2 emissions could reach about 90% with HDR integration in the steel manufacturing.

Assessing the Eco-Efficiency of the Electricity Sector through a Novel Productivity Index inspired by the Value-Based Data Envelopment Analysis

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Keywords: Value-Based Data Envelopment Analysis; Productivity; Additive Multiattribute Value Functions

The electricity sector is of paramount importance both to the economy and to the environment. Therefore, the assessment of electricity generation systems has attracted much attention, explicitly addressing their eco-efficiency. This latter concept is intrinsically related to sustainability in the sense it encompasses at least two of its pillars, i.e., economics and environment.

In this context, Data Envelopment Analysis (DEA) can be particularly useful since it allows coupling into a single indicator the multiple axes of sustainability assessment, facilitating the process of policy decision-making. Within the electricity sector context, the main contribution of the present work is to join the eco-efficiency assessment with a novel productivity index based on Value-Based Data Envelopment Analysis.

Our findings show that most countries attained productivity gains in the direct production chain of the electricity sector according to a neutral perspective, while the opposite occurs when we follow an environmentally demanding stance (only nine countries show Total Factor Productivity (TFP) gains). In addition, while under the former value functions TFP gains are mainly driven by technological progress, according to the latter value functions these are mainly supported by efficiency gains. These outcomes are related to the stringent conditions imposed by the configuration of nonlinear value functions depicting a more environmentally demanding preference.

In the direct consumption chain except for Denmark, Spain, and Germany almost all countries show productivity gains following a neutral perspective, while under an environmentally demanding stance the number of countries showing TFP losses increases to seven. Nevertheless, the majority of countries manage to get productivity gains for the activity sectors that directly supply the electricity sector mainly supported by technological progress according to both types of value functions. In the indirect supply chain, most of the countries had positive total factor productivity (23 and 19 for the for the neutral and environmental perspectives, respectively) and the majority of the countries underwent technological progress. Either way, the biggest frontier shift belongs to Germany across all chains of the electricity sector.

Germany, Luxemburg, and Belgium were consistently considered as “innovators” across all chains of the electricity sector and following both perspectives.

Since the number of countries facing TFP losses in the environmentally demanding perspective always increases across all chains, our findings show that a restructuring of the EU electricity sector should be fostered to enhance the eco-efficiency of this sector.

Sensitivity Analysis in Value-Based DEA Method applied to Eco-Efficiency of the Electricity Sector across EU

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Keywords: Eco-Efficiency; DEA; Multi-Criteria Decision Analysis; Uncertainty; Stability Intervals

Data Envelopment Analysis (DEA) can be particularly useful since it allows coupling into a single indicator the multiple axes of evaluation of sustainability, facilitating the process of policy-decision making. In this work we specifically consider the Value-Based Data Envelopment Analysis (VBDEA) approach, which joins the use of DEA with Multiple Criteria Decision Aiding (MCDA), considering the main factors that might influence the eco-efficiency of the electricity sector. When contrasted with the traditional DEA method, VBDEA has several innovative features because it converts inputs and outputs into value scales. Besides, this can be particularly convenient not only for including the preferences of the Decision-Maker (DM) but also for easily handling negative or null data. We incorporate the preferences of a hypothetical DM, by assuming that a more environmental prone policy-maker would have value functions inspired by the value function of Tversky and Kahneman (1992), i.e. normally concave for economic concerns (such as capital, GVA and employment) and convex for environmental impacts, being steeper for environmental concerns (viewed as losses) – thus assuming that countries with a higher capacity of generating wealth allocate a lower value to its increments than those with lower capacity, and that a country with higher levels of environmental performance allocates a higher penalization value to emissions increase.
In this approach the uncertainty in the coefficients in each factor (input or output) is captured through interval coefficients and converted into value scales (which are always to be maximized). An optimistic efficiency measure and a pessimistic efficiency measure are computed. In addition, a tolerance threshold for each efficient DMU is determined, that is, a maximum tolerance in the factor scores for which the DMU's efficiency status changes. We compute a stability interval in terms of a parameter that affect all the factors. Using these two types of efficiency measures, we can classify the DMUs as surely efficient, potentially efficient, or surely inefficient.
The results show that Germany and Luxemburg are the most robust countries for Direct Production Chain, Direct Supply Chain and Indirect Supply Chain for perturbations in data of 5%, 10% and 20%.

GreenYourRoute - Vehicle Routing Problem Modeling & Solution Approach

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Keywords: GreenYourRoute; Vehicle; Routing; Problem; LIFE

Road freight transport and logistics operations in general, essential for the economic development, have several harmful effects on the environment. LIFE GreenYourRoute project is a project currently implemented with the contribution of the LIFE programme of the European Union and the co-financing of the Greek Green Fund, aiming to develop a European innovative logistics platform for last mile delivery of goods in urban environment, within a multidisciplinary approach of environmental engineering, computer science and operations research. The core objective of the project is to reduce produced emissions from transport by solving Green-Vehicle Routing Problems.

The main idea of the vehicle routing problem developed under the frame of LIFE GreenYourRoute project was to develop a modeling and solution approach that could be easily applied and adopted by logistics companies, especially small and medium sized ones, and cover substantial daily routing operational requirements and therefore increase the transferability and replicability of the produced platform. The approach was based on the 5 demonstrators routing requirements communicated to the project team and cover several real-life aspects. The objective of the approach is to minimize transport cost taking into account environmental considerations.

The abovementioned problem is an NP-hard problem and therefore cannot be solved optimally, using mathematical programming. To solve the problem a hybrid approach was developed, including both heuristics and steps based on mathematical programming models.

At the beginning of the solution algorithm, a k-means clustering is performed. Then vehicles are assigned to the created clusters by maximizing compatibilities of vehicles and clusters or minimizing the distance of the vehicle's location from the cluster's centroid. Then, orders are assigned to clusters taking into account customers restrictions and vehicle attributes. Finally, a TSP is solved.

Initial results achieved by the developed approach indicate an average improvement of 16%; future work includes the exploration of decomposition techniques for the TSP step of the algorithm, as well as the addition of the necessary steps to also cover the case of the Periodic Vehicle Routing Problem instances.

Solving Travelling Salesman Problem with Multiple Benders-decomposed Subtour Elimination Constraints

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Keywords: TSP; Benders Decomposition; Subtour Elimination Constraints

Routing problems have a large variety of variants. Going from the Travelling Salesman Problem (TSP) to Vehicle Routing Problem (VRP), a lot of parameters may vary, such as Capacitated-Uncapacitated, with/without Time Windows, Heterogenous/Homogenous Fleet, Periodic etc. However, all variants share common constraints known as Subtour Elimination Constraints (SECs), which guarantee the creation of a Hamiltonian cycle. Without these constraints, the solution of the TSP would result into numerous subtours, which would not be connected with each other. This papers focuses on the classical TSP model and studies nine different formulations of SECs, already published in the literature. The authors apply the Benders Decomposition method on the TSP for each of these formulations. Thus, the SECs are removed from TSP and the remaining model is the Assignment Problem (AP), which constitutes the Relaxed Master Problem (RMP). Each of the nine different formulations of SECs is transformed into the Primal Subproblem (PSP) of the method. In every iteration of the Benders algorithm, the solution of AP (i.e. the RMP) contains subtours, which are gradually eliminated by the Benders feasibility cuts generated by the PSP.
The main scope of the work is to study the Benders feasibility cuts created by each of the nine different formulations of SECs and to categorize them based on their efficiency. For this reason, benchmark data from TSPLIB for asymmetric TSP are solved both for each of the nine different formulations and for combinations of them. The results are analyzed and compared both with the solution of classical TSP model including SECs by the commercial solver CPLEX and with a state-of-the-art heuristic algorithm.

Carbon Uptake Rate and Biomass and Lipid Productivities of Chlorella Protothecoides cultivated Heterotrophically with Crude Glycerol

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Keywords: Chlorella Protothecoides; Heterotrophic; Glycerol; Lipid Productivity

The growth kinetics and the lipid and protein content and productivities of the microalgal species Chlorella protothecoides (SAG strain 211-7a) grown heterotrophically, using five different amounts of glycerol as the sole source of organic carbon, were studied. The cultivation took place in 5 L glass bioreactors. The bioreactors, the glass tubing and the culture medium were sterilized before use. Air was continuously passed through the solution at 300 L/hr though a 2 mm glass tubing positioned at the tip of a magnetic bar and the air bubbles were dispersed with a magnetic bar at the bottom of the glass flasks. The composition of glycerol was approximately 86% glycerine, 0.5% methanol, 4% MONG (Non-Glycerine Organic Matter) and 7.5% H2O. Initial carbon concentration was equal to 0.056, 0.60, 1.28, 2.95 and 6.46 g/l while, the initial total atomic nitrogen concentration was held constant at 45.4 mg/l of which 27.7 mg/l was in the form of ammonium and 17.7 mg/l in the form of nitrate. Therefore, initial carbon to nitrogen (Co/No) ratios were equal to 1.2, 13.3, 28.2, 65.1 and 142.3, varying by more than two orders of magnitude. The kinetics of carbon uptake was monitored daily by measuring the organic carbon concentration in the growth media. The growth media, with respect to potassium, phosphorus and micronutrients was the Basal Medium (= ES "Erddekokt + Salze").

It was found that the initial concentration of carbon or the Co/No ratio affected significantly the kinetics of growth of the biomass of Chlorella protothecoides as evidenced by the rate of carbon uptake and the biomass productivity. For initial carbon concentrations up to 1.28 g/l, carbon was consumed within 3 days. However, increasing the initial carbon concentration 2.95g/l it took about 13 days for it to be consumed and at Co=6.46 g/l about 87% of the carbon was consumed in 16 days. This is probably due to a decrease in the available nitrogen. The carbon uptake rate above Co=1.28 g/l increased slightly from 0.26 g/(l-d) at Co=1.28 g/l to only 0.31 g/(l-d) at Co=6.46 g/l. Carbon consumed beyond Co=1.28 g/l or Co/No=28.2 is probably utilized to a greater extent for lipid accumulation. For Co/No = 1.2, 13.3, 28.2, 65.1 and 142.3 the biomass production was 0.07, 0.15, 0.70, 1.20 and 1.95 g/l respectively and the respective biomass productivities (on a dry basis) were 0.035, 0.043, 0.12, 0.10 and 0.12 g/(l-d). Biomass productivities do not increase past Co/No=28.2 because of the longer cultivation period needed. However, lipid content increases substantially as the Co/No is increased and the reverse holds true for the protein content. For the

aforementioned Co/No ratios the lipid content was equal to 6.1, 17.1, 22.4, 29.6 and 35.7% (w/w). Therefore, the lipid productivities as the Co/No increases, are equal to 0.002, 0.007, 0.027, 0.030 and 0.043 g/(l-d). It is evident that high initial ratios of carbon to nitrogen favour lipid accumulation. Other cultivation techniques, such as semi-batch growth may enhance biomass growth and, retaining the high biomass lipid content, and therefore improve lipid productivity which is essential for commercial biodiesel production.

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Me-N-C (Me= Fe, Co) Electrocatalysts with EDTA-derived N for Dopamine Electrochemical Detection

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Keywords: Dopamine Enzymless Sensor; Electrochemical Sensors; Nitrogen Doping; Non-Precious Metals

Neurotransmitters are chemical transporters that exchange signals between neurons and other cells. Measuring their concentrations in vivo is a very challenging procedure, firstly because the extracellular concentrations of neurotransmitters are very low and can change rapidly and secondly because they co-exist with many electroactive neurochemicals in the brain interfering the neurotransmitters detection. Dopamine (DA) is a catecholamine, modulating many parts of brain circuitry. Abnormal levels of DA are associated with neurological disorders such as schizophrenia, Alzheimer's and Parkinson's diseases. Herein, we synthesized low-cost electrocatalysts using a template-free, synthesis method with ethylene diamine tetra acetic acid (EDTA)-nitrogen precursor, carbon substrate and Fe or Co nanoparticles. (EDTA) nitrogen precursor is a low-cost bio-compound that reduces the cost and the environmental impact of the nanocatalysts synthesis. Co and Fe nanoparticles are accepting important attention in the research community, along with other functional nanomaterials, mainly due to their easy processing, structural and surface properties, low cost, biocompatibility, remarkable stability and environmentally friendly recommendation. Both electrocatalysts were investigated towards dopamine oxidation reaction (DOR), in alkaline medium. The amperometric response of the Co/KB-N electrocatalyst, that presented the best behavior towards DOR, was also evaluated in human's body conditions (pH=7.25, T=36.6 ºC).

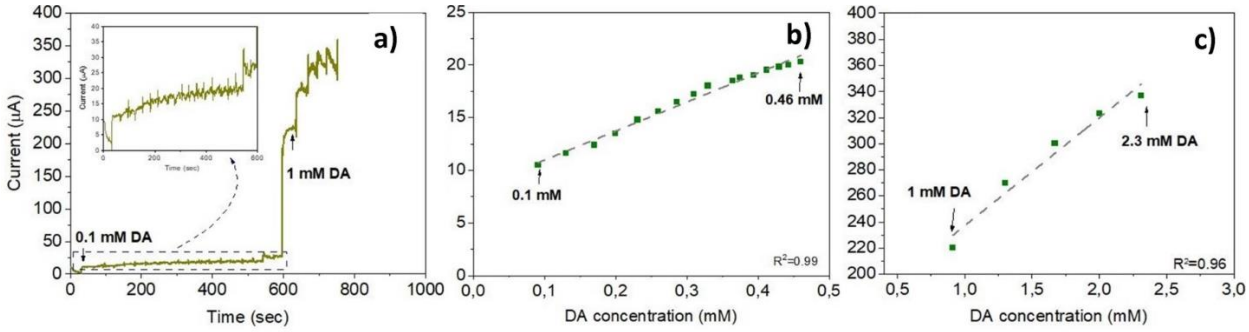

Figure 1. Amperometric response of Co/KB-N in 0.1 M PBS, at 0.2 V vs Ag/AgCl (f), current response vs DA low concentration (g) and high DA concentration (h).

In Fig.1 it can be observed that as the concentration of DA increases, the current response also increases gradually, for a specific range of concentrations (Fig. 1a). Moreover, according to the i-DA concentration correlations (Figs.1b&c) the sensitivity at low concentration range, calculated 393.0 μA mM^{-1} cm^{-2} and the LOD 0.54 mM, while at high concentration range, 1185.7 μA mM^{-1} cm^{-2} and 0.84 mM, respectively.

The Closed-Open Truck and Loader Routing Problem for Biomass Transportation from Satellite Storage Locations to a Bioenergy Plant

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Keywords: Biomass Transportation; Closed-Open Vehicle Routing Problem; Mathematical Modeling; Heuristics

The cellulosic bioenergy industry has a crucial issue: collecting sparsely distributed cellulosic biomass requires complicated operations that involve many costly machines and workforces. The complex daily operation and movement of costly machines transporting biomass to bioenergy plants can significantly affect the economic viability of the system. In particular, while a truck should have a closed route from/to the bioenergy plant, a mobile loader may have different departing and returning locations.

This study formulated the closed-open routing of mobile machines as a mixed-integer linear programming model considering other challenging modeling factors such as muli-trips, multi-visits, and synchronized loading operations. This problem is named the closed-open Truck and Loader Routing Problem for Biomass Transportation with Open Routing. The presented problem needs to prescribe the daily working schedule of loaders and trucks—which determines the number of trucks and loaders—as well as the closed route of each truck, the open route for each loader, the amount of biomass transported from each satellite storage locations (SSLs), and the arrival and loading working time of each machine at SSLs. Moreover, it should consider all system restrictions such as different starting locations, synchronized loading operation, required loading time, and available working hours per day. The coTLRPBT aims to minimize total costs, which include transportation, loading, and machine owning costs, while transporting the daily target amount of biomass from the selected SSLs to a bioenergy plant.

A constructive heuristics-based solution method has been developed to solve the problem effectively for practical use. The proposed heuristic is based on the idea of assigning the first available machine to an SSL where biomass needs to be transported, considering the remaining operation times of machines. We name this algorithm supply-resource matching heuristics, the worst-case complexity of which is $O(n_1n_2(n_1+Sn_2)m)$, where n_1 and n_2 represent the available number of loaders and trucks, respectively, m is the number of SSLs, and each of SSLs supplies S truckloads of biomass.

The numerical studies with real-life examples, based on a region in Southwestern Ontario, Canada, showed that the model made operating schedules correctly for real-life examples. The developed solution method outperformed a commercial solver, reducing the total costs up to 12.5%. It also found feasible integer solutions of difficult cases, for which a commercial solver could not do. Further analyses showed the effectiveness of the developed heuristics compared to the CPLEX heuristics-and-cuts at the branch-and-bound root node.

Bioenergy Production employing Microbial Fuel Cells (MFC) with Honey Comb Flow Straighteners

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Keywords: Honey Comb Microbial Fuel Cells; Flow Straighteners; Bioenergy; Wastewater Treatment; Electrode Spacing; Channel Diameters; Numerical Simulation

The pursuit for alternate environmental-friendly energy sources is being established in the wake of environmental concerns like global warming and climate change. Microbial fuel cells (MFCs) are bio electrochemical transducers that can be used to produce electrical power under the activity of microbes during the wastewater treatment processes. Flow parameter investigation has been conducted in innovative flow straightener implemented honey comb MFCs (HCMFCs) in the current research study where the impacts of flow channel diameter on the performance of the reactors operated in recirculation batch mode have been estimated. Along with that the effects of spacing between the anode and cathode electrodes on the reactors performance was also elucidated. Three reactors (HCMFC1, 2 and 3) with different channel diameters like 0.4 cm, 0.7 cm and 1 cm and electrode distances of 0, 3 and 6 cm were designed and operated along with a control reactor devoid of flow straighteners. Numerical simulation models were presented and analyses like Nyquist plots, polarization curves, power density curves and equivalent circuits were done. The HCMFC 2 reactor with 0.7 cm showcased the best performance by achieving a voltage generation of 0.55 V, current density of 5300 mA/m^2, power density of 430 mW/m^2, organic content removal of 97.6%, reduced internal resistance. Results showed that a higher limiting current density with 4108.7 mA/m^2 and a lower resistance with 2.51 Ω can be found in the case of the 0.0 cm electrode spacing. Result justification was accomplished by anode biofilm thickness analysis using scanning electron microscope. These results also indicated that the shorter electrode spacing with flow straightener devices would improve the performance of MFCs, leading to lower internal resistance and higher power density. The best performing reactors had the highest anode biofilm thickness which served as a proof for their heightened power production and treatment ability. These innovative flow straightener MFCs will effectively enhance research and provide great prospects for future applications.

Society 5.0 and Industry 5.0 ad driving Forces for Co-Creating Sustainability. Quintuple Helix Approach

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Keywords: Human Oriented Innovation; Social Innovation; Co-Production; Crowd-Mapping Tool; Participatory Research; Quadruple and Quintuple Helix

The concept of Society and Industry 5.0. is not a simple chronological continuation or alternative to Industry 4.0 paradigm. Society 5.0 aims to place human beings at the midpoint of innovation, exploiting the impact of technology and Industry 4.0 results with the technological integration to improve quality of life, social responsibility and sustainability (Carayannis et al., 2021, Carayannis 2020, Fukuyama, 2018). This ground-breaking perspective has common points with the objectives of the United Nations Development Program "Sustainable Development Goals" that cannot be met from a unilateral perspective and social innovation is recognized as an important component of this new framework. In our presentation we argue that incorporating the assumptions of Society 5.0 and Industry 5.0 into the universities practices and policies will allow both universities and societies to fully benefit from digital transformation for sustainable purposes. Making the human oriented innovation as the universities trademark and developing new cooperative models will help also to achieve sustainable priorities (EUA, 2021, Hamaguchi, 2020, Morawska-Jancelewicz, 2021). Covid-19 pandemic has undoubtedly accelerated those processes and gave evidence that universities have a crucial role to play in new Society and Industry 5.0. It has also highlighted the need to re-think existing working methods and approaches. The use of the Quintuple Helix Model (QHM) might foster the process of necessary transformations capacities as it integrates different perspectives and sets the stage for sustainability priorities and considerations (Carayannis et al. 2020, Carayannis et al. 2021, Carayannis 2017, Carayannis & Rakhmatullin, 2014). We will particularly focus on success factors for stakeholders-academic partnerships and the relevance of hands-on activities and supportive tools. As far as the practical goal is concerned, we will propose a set of recommendations aiming at developing new forms and channels of distribution of education, research and innovation for sustainability within in the context of QHM and Society 5.0.

The Agenda that Changed the World - Agenda 2030 and the 17 Sustainable Development Goals

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Keywords: Transformational Change; Conceptual and Systemic Change; Political Repercussions

The 2030 Agenda is all about 'transformative change' and has inspired a slow but interesting discussion of what transformative change may mean. As this is a primary aspect of the 2030 Agenda, the concept of change calls for a deeper investigation of what change implies. Theories of change are used, but in many different aspects. A dominant element in the 2030 Agenda politics is change for a better future. As we are speaking about an end result in 2030, 9 years from now, the future is an indelible element of this change. An investigation into the future complex as an integral element of the transformative change element should therefore be discussed to see if transformative change concept has had a real impact. Some claim that this has resulted in several initiatives with law and regulatory consequences, such as - the EU Taxonomy for Finance, the development of National Strategies for Sustainable Development – now a political fact in around 60 countries, and an annual reporting on the 2030 Agenda to the UN. In fact, all but a few countries, have given at least one report to the UN on the 2030 Agenda.

The 2030 Agenda has permeated all planning systems and has led to what may be called the national and global 2030 Sustainable Development Portfolio. There is growing realisation of this phenomenon, but as yet this has not been researched or scrutinized by the research community. The consequences of the portfolio are many and has already had a serious impact on multilateral institutions and on multilateral collaboration. What does this imply for future political work, research, knowledge accumulation and focus as well as education?

The 2030 Agenda encapsulates a number of challenges to existing political systems, and without proper governance elements in place, the Agenda will not succeed in fulfilling its ambitions or goals. The concept of good governance is seen as an enabler for the implementation of all the SDGs with their targets and indicators and allows for greater participation of people in identifying, deciding and implementing their future. This has already created a dynamic which has resulted in challenging present political processes and given rise to growing opposition to present politics in many spectres of the political spectrum. The internet has been used to involve people in greater quantity in informing about the Agenda and governance. However, does the internet bring the necessary benefits? Are participation and decision-making opportunities increased? Access may be said to be better, but is access understood properly? Does access allow for influence? Both elements are crucial elements in governance and in delivering on the 2030 Agenda.

Finally, a recurring debate witch also has a basis in ethics and moral philosophy is about the necessity of governments to implement the 2030 Agenda and build back better, after the pandemic. There is a growing realisation that we all have to accept sustainable development as the dominant development paradigm. However, the question arises whether we – the nations and the world - have accepted sustainable development as the dominant development paradigm, or not. Will sustainable development be the concept that allows for a better future – to fulfil the promise made by state leaders in agreeing to the Rio Outcome document which they unanimously named "The future we want". Will sustainable development give the

necessary impetus to think out of the box and blow apart the silo-thinking or will such approaches undermine the necessity of expert knowledge? The concept of Leave No One Behind (LNOB) is now integrated into the 2030 agenda almost as a truism. Does the LNOB accentuate the new paradigm, or has it just become another way of packing charity instead of implementing real systemic and substantive change? Can we then finally conclude with the following: The 2030 Agenda will be give all an opportunity to renew the social contract with a better future for all.

Science – Society Relations: A Global Framework and a Case in Practice

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Keywords: art+science (Programme); European ARTificial Intelligence Laboratory; AI Lab (project); Responsible Research and Innovation (RRI); RRING (project)

Conceptually from 2010 and practically since 2014, the Responsible Research and Innovation policy (RRI) has been shaping European R&I environment during the period covered mostly by the Horizon 2020 programme. Novel framework – Horizon Europe – is looking (far) beyond existing scope, trying to create a functional symbiosis with the UN's Sustainable Development Goals policy (SDGs). Although core elements and key RRI values will be integrated, the question remains how to practically align Europe-oriented policy with a global system that has its priorities and specificities. H2020 project RRING may offer insightful and relevant perspective, being conceived as a truly global endeavour with a goal to assess related policies and research practices under the umbrella of UNESCO Recommendation on Science and Scientific Researchers. The Recommendation was unanimously adopted in 2018 by the general council of UNESCO consisting of 193 member states. The Recommendation is an inspiring global mechanism for bringing science closer to all citizens and establishing an independent and stable environment for the advancement of research processes.

In parallel with European participatory and open R&I practices, the Center for the Promotion of Science (CPN) has been actively working on creating a sustainable network which may gather scientists and artists, encourage their collaboration, and support development of joint projects. art+science programme was conceived in 2014 while formally introduced as an annual event in 2016, with an intention to initiate and support interdisciplinary collaborations. The emphasis is now given to the artificial intelligence (AI) which proved to be distant, abstract and incomprehensible for the most of general audience. A vast majority of people is staying outside processes which are shaping our both □ physical and virtual □ realities.

AI needs a critical societal analysis and valorisation, and its values and meaning should be integrated into formal educational processes, however informal educative formats targeting all ages should be stimulated as well. It could even become a driving force of the STE(A)M educational framework. Among the attempts to open up the AI, as a super-technology capable to produce remarkable outcomes, one can be easily distinguished. Co-funded by the EU Creative Europe programme, the European ARTificial Intelligence Lab – AI Lab project focuses on aspects beyond the technological and scientific horizons to scrutinize cultural, psychological, philosophical and spiritual aspects. The AI Lab consortium of 13 diverse partners across Europe brings AI related scientific and technological topics to general citizens and art audiences in order to contribute to a reflective society; in that sense, a critical and creative assessment of the AI is put in a centre of its focus.

Embedding Service-Learning within HE Curricula to tackle Contemporary Challenges of University-Community Engagement and Partnerships

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Keywords: Service-Learning; Off-Grid System; IoT Solutions; Community Needs

Strengthening the social dimension in education has been an important European priority, that has been accentuated even further by the Commission in the renewed EU agenda for Higher Education. Universities are increasingly expected to be responsive to the needs of society and to engage with a wide variety of external stakeholders.

In this context, innovative curricula and teaching approaches are seen to contribute on one hand to reducing the current high-level skills gap between students and labour market needs and, on the other hand, in addressing a real "need" identified within the community.

The service-learning approach aims to strengthen the students' relationship with the community, with a view to their personal development and civic engagement (Menezes, 2003, Barber, 1991; Colby & Damon, 1992; Dewey, 1966; Waldstein & Reiher, 2001). The essential elements of this learning approach entails the active involvement of students in solving a need identified in the community and intentionally providing spaces for reflecting upon the experiences (Leming, 2001; Trainor, Muscott & Smith, 1996).

The presentation is centered on the experiences and lessons learnt during the implementation of ENGAGE STUDENTS project funded under the ERASMUS+ (engagestudents.eu) in promoting service-learning as an innovative teaching and learning methodology within HE curricula. Two service-learning projects addressing SDGs will be on focus: Monitoring off-grid systems through IoT solutions aimed at developing a monitoring system for the electrical parameters of an off-grid solution that can forecast energy production and thus a more efficient use of renewable energy sources and Indoor air quality monitoring via RESTful API and HVAC control via IoT that addressed the development of an IoT solution for collecting the air quality parameters and processes the data to sustain a comfortable living environment in a residential building.

Inclusive and Green Internationalization Initiatives

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Keywords: Internationalization; Green & Digital Solutions; Students' Mobility

Internationalization has traditionally been for those more confident with travelling, for those with financial support from families and for the brave. Internationalization, has, therefore, left out a large proportion of students. The covid19 pandemic has made higher education institutions revise their current activities and forced them to innovate and find ways to bring into the institution the international experience. Internationalization at Home is not a new concept, but it is now at the center of internationalization strategies of institutions across the world. At the University of Girona, we have focused on introducing internationalization activities that are more inclusive, green and digital. Providing students with intercultural experiences and competences without having to participate in mobility schemes. These initiatives offer different pathways for students to gain global citizenship skills and competences that are academically recognized and appear in their degree.

The Use of Biogas as a Source of Bioenergy within 1G2G Ethanol Biorefineries Through Residues Co-Digestion

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Keywords: Methane; Sugarcane Residues; Anaerobic Digestion; Bioenergy

The debates on issues of global warming and reduction of greenhouse gases are common knowledge, and in this scenario, bioenergy gains strength and stands out as an efficient alternative. With the industrial development of the countries, an exponential increase in energy consumption will occur, and at the same time, energy demand will increase by an annual average of 1.6% by 2030. The importance of using biomass for power, heat, and fuel generation is increasing on a global scale. In this promising and challenging context, the production of biogas is returning to prominence and, consequently, has received numerous initiatives. Biogas (60–70% CH_4, 30–40% CO_2, and the rest are the impurities) is considered a versatile energy carrier, which can be used to replace fossil fuels in the production of both electricity and heat, as well as used as a gaseous fuel for vehicles. Anaerobic digestion (AD), an attractive process for the management of liquid and solid waste that allows energy recovery through methane (CH4). The co-digestion, process where is used two or more residues in AD, has been highlighted since is an option to use poorly biodegradable substrates and providing and balancing macro and micronutrients for the AD process. The AD of vinasse, residue from the production of 1G ethanol, is already successfully disseminated in the literature, reaching CH_4 productions that can be used as an energy source within the ethanol mills. In addition to vinasse, the production of 1G ethanol generates other residues with the potential for CH_4 production through AD, such as filter cake. However, the literature reports little about the use of residues from the production of 2G ethanol, mainly from the use of liquors originated from pretreatments of lignocellulosic residues such as sugarcane straw or bagasse. Among these residues, the deacetylation liquor is a residue obtained from the pretreatment of sugarcane straw and has a high biochemical potential. Therefore, the present study aimed to co-digest vinasse, filter cake, and deacetylation liquor to produce CH_4 in a continuous reactor, in a thermophilic process. It was possible to obtain a production of approximately 230 NmLCH_4 gVS-1 (VS-volatile solids), emphasizing that the co-digestion of these residues is effective for energetic recuperation in sugarcane biorefinery, in addition to allowing the integration of 1G2G ethanol biorefineries. Considering the entire volume of waste produced in the harvest (232 days ~ 7 months) it is possible to obtain a monthly electricity production of 17 x 106 kWh (considering an engine with 38% efficiency) for the sugarcane mill. Considering that the residential energy consumption per capita in Brazil is 38 kWh per month, this amount of electricity generated is capable of supplying a city with 4.6 x 106 inhabitants. These results also show an advance for the use of bioenergy within these biorefineries and show that biogas plays an important role in the context of the introduction of bioenergy in the current world, proving to be a strong candidate to supply the conditions for reducing greenhouse gases and generating renewable energy.

Modeling Energy Systems to contribute to the Sustainable Development of the Dominican Republic

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Keywords: Energy Planning; Small Islands Developing States; Energy System Modelling; Decision Support; Energy Systems Analysis; Renewable Energy

The Dominican Republic (DR), like the rest of the Small Island Developing States (SIDS) declared by the United Nations in 1994, is highly vulnerable from geographical and economical point of view. Climate change and the high dependence on fossil fuel imports are the main causal agents of this vulnerability. The responsible authorities on the island have decided to transform the energy sector to reduce greenhouse gas emissions and the use of fossil fuels, mostly imported. This process requires identifying the optimal routes to transform the country's energy matrix.

Recent publications consider that the most appropriate solution to energy supply for SIDS, including the DR, are Renewable Energy Sources (RES). In the country, the measures taken in the last decade to diversify the energy matrix were aimed at the installation of a 782 MW coal-fired power plant, a gas pipeline that allowed the transformation of some 750 MW from Fuel Oil to Natural Gas at the same time as 187.46 MW of photovoltaic solar energy and 370.25 MW of wind energy have been installed.

In the last decade, a large number of tools have been developed to support decision-making, however, in the DR the potential of these tools for scientifically based planning focused on sustainable development is not yet used. The OSeMOSYS modeling tool is considered to be a tool where the special conditions of the energy systems of SIDS can be considered, therefore, it is used in this work to investigate the impact of political decisions made by the State in recent years and determine the most appropriate route of energy matrix for a sustainable development with clean and accessible energy. The trend in the evolution of energy supply systems indicates that renewable energy technologies will play an important role, which can be enhanced by regulatory and market changes that provide a favorable scenario for their deployment in the shortest time and at the lowest cost.

In this research, a Business As Usual (BAU) scenario was built which electricity demand until 2040 was obtained from a polynomial regression of the historical data in the period 2006 - 2020. If the production

costs of the power plants of the system do not vary, the model recommends installing new coal-fired power plants, this would increase CO2 emissions by 100% by 2040 compared to the scenario where energy production from coal is limited. In this last scenario, the model suggests the installation of technology based on natural gas and the RESE, both wind and solar, would cover between 4 and 6% of the total energy generation each year. According to the model, total energy production in 2040 will be 41 666.67 GWh.

Mapping the Sustainability Discourse in Digital Entrepreneurship: An Analysis of Investment Allocation of Sustainability Focused Tech Start-Ups

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Keywords: Digital Entrepreneurship; Sustainability; Topic Modelling; Latent Dirichlet Allocation

Digital entrepreneurship has become one of the foundational pillars of the economy, with much capital been allocated to disruptive technologies and platforms that will enable the transition to a more sustainable form of economic activity. Following on the lead of Tesla and other companies betting on the electrification and disruption of the transportation industry, several start-ups have shared their goals and vision with investors, seeking access to capital to finance the development of products and services that will eventually benefit consumers and the environment. Using a unique dataset sourced from Crunchbase, a database collecting and categorizing investment decisions on companies in various areas of economic activity; we perform text mining to map the themes in a company's own stated goals with the outcomes in investment funding as well as the different areas of the sustainability domain using topic modelling and latent Dirichlet allocation. More specifically, by utilizing the CrunchBase categorization of the sustainability domain of a company's activity, we source information for more than 2,300 companies, including a company's own description, sub-area of activity (e.g., transportation, energy, etc.), operational (number of employees, year of incorporation) as well as innovation elements (e.g., number of patents, number of trademarks). We couple this information with investment outcomes, such as the number and size of funding (investment rounds and total amount) to evaluate longitudinal outcomes of investment decisions, using a panel-regression framework informed by the themes appearing in the company's own goals as reflected on their formal description.

Our work aims to answer tangible research questions pertaining to the intertwined nature of sustainability, entrepreneurship, and new technologies both at a platform and an individual product level. Using Bayesian inference, we estimate the document-topic proportions and word-topic probability distributions of the themes appearing in the company description text using investment outcomes as priors in a modified latent Dirichlet allocation process that accounts for specific covariates (structural topic models). This text-mining framework allows us to evaluate marginal effects in investment outcomes using qualitative dimensions extracted from the company description text, also controlling for the sub-area of activity across the sustainability domain that each company is primarily active.

Our analysis is of key importance to investors, entrepreneurs and policymakers who seek to become active in developing, funding, and nurturing economic activity that will result in sustainable outcomes for consumers and society. Using longitudinal analysis, we also map the evolution of the sustainability domain and the funding across time in order to evaluate adoption trends. The results of this analysis can primarily

inform entrepreneurs regarding the development of new business ideas that reach funding maturity and policymakers on what kind of sustainability technologies are mature enough to be nurtured in a policy framework that encourages entrepreneurial activity.

Sustainable and Digital Agricultural Supply Chains: A State-of-the-Art Review on AI-driven AgriTech Research

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Keywords: Digital SC; Agricultural SC; Agricultural Technology (AgriTech); Literature Review

Digital Supply Chain (SC) as an evolving field has recently gained significant interest in various industries, including agriculture. Industry 4.0 paradigm has transformed the context of AI-driven digital SC in agricultural sector with applications of agricultural technology (AgriTech) and a strong focus on data-driven analytical techniques. The study herein presents a state-of-the-art review of the research advances in AgriTech field which are, evolving in a fast pace over the last decades. Drawing on the established principles and protocols for systematic literature reviews, we develop a categorisation of the various types of AgriTech, as well as the associated AI driven techniques which form the dynamically defined context of AgriTech. The contribution primarily builds an initial conceptualisation and extends the awareness about AI-driven AgriTech context relevant to the digital SC of the agricultural sector. The study provides a single normative reference for the definition, context, and future directions of the field for further research towards the digital SC context of AgriTech. Our findings indicate that AgriTech research is in infancy in regard to application, processes, practices and a number of evolving potentialities for the agricultural SC Research. Through the review we inform a wide range of agricultural stakeholders and provide research agenda for future research in the field.

Coordinating Decisions of Delay-Sensitive Customers via Service Provision Aggregators

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Keywords: Sustainability; Supply Chain Management; Game Theory; Demand Aggregator; Outsourcing; Queues with Strategic Customers

In the recent years, there is an increasing trend for collaboration in cases of intangible products such as services. This is evidenced by the flourishing of virtual platforms, e.g., for taxi services, maintenance services, etc. Moreover, another important factor that affects the demand and the channel performance in general is the lead time. In a service system, the lead time is typically manifested as queueing delays experienced by customers. In this work, we analyze the problems of double marginalization and supply chain coordination, as the manifest themselves in a service system with delay-sensitive strategic customers. Specifically, we consider a service provider who decides whether to provide a service directly to customers or use a demand aggregator's channel, but not both. The aggregator is responsible for customer contact and all the related actions. In the first case, the provider incurs a direct cost related to customer contact and charges customers with a retail price. In the second case, the provider charges the aggregator with a single price per served customer and the aggregator sets his own retail price. We model the problem as a Stackelberg game between the provider and the aggregator under strategic customer behavior in an unobservable setting. We prove that under the single price class of policies the resulting equilibrium is not generally socially optimal because of the double marginalization effect. However, channel coordination can be achieved without side payments between the two parties if the provider uses the aggregator's channel but also provides a direct compensation to the customers, proportional to the delay in filling the order. We also explore how channel coordination is affected by the provider's direct service cost, the market size, as well as the aggregator's reservation level for participation. We derive the pricing strategies under both single price and price/delay compensation schemes and determine conditions so that it is optimal for the provider to collaborate with the aggregator.

Stochastic Modelling for an LNG Refueling System Design

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Keywords: LNG; LNG Bunkering; Mathematical Modelling; Stochastic Optimization; Monte Carlo Simulation; Queuing Theory

Port activity is assumed to be an integral part of maritime activity. Therefore, the purpose of the service system is to reduce the waiting cost, from the time the ship's arrival until its service. Delays in the system, and particularly in the queuing system, could occur due to irregularities in the ships' arrival time causing uncertainty in time of service. A complex waiting system would require an increased commitment of capital for the construction and maintenance of appropriate infrastructure. Hence, an optimum size and operation of the port service system must be identified.
This study presents a method for maximizing port administrator's profit, by modelling and optimizing the waiting system based on Monte Carlo simulation techniques. Port of Piraeus is used to test the method. The case study assumes increased bunkering port calls due to the addition of an LNG refueling station.
The results showed that a range of 3 to 5 stations generate high profit while using too many service stations could lead to deteriorations of the profit.
Originality/value – This study could benefit other researchers, as it presents a general methodology to design an LNG refueling system, that will not only be limited to the specific ports or fuels that were targeted in this study, but it could be easily adopted in other refueling systems. It provides a thorough analysis through a case study to enhance the decision-making processes.

The Electric Vehicle Routing Problem with Drones

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Keywords: Sustainable Logistics; Urban Transportation; Electric Vehicle Routing Problem; Ant Colony Optimization

According to the European Environment Agency, more than 70% of greenhouse gas emissions come from road vehicles, obscuring the climate goals set by the European Union (EU). In the coming years, logistics companies will be required to shift from traditional vehicles to Electric Vehicles (EVs). New laws are constantly being put in place that prohibit either the sale or even the use of some kinds of traditional vehicles. Austria will ban the sale of new non-electric vehicles by 2025 and in the same year Norway will ban all diesel and gas-powered cars. Other countries and cities follow suit with goals set for 2030, such as France. Subsequently, EVs are unquestionably the future of mobility and transport. Great progressions of the related technologies in the last two decades, mainly battery technologies, make them more appealing. Range remains their biggest shortcoming, but, when handled properly they can prove to be quite beneficial. Prices have been decreasing and governments provide tax relief incentives. EVs operate quietly, without any local emissions, making them perfect for urban transportation. The focus will be around light-weight vans, electric versions of which are commonplace in today's market.

In the last few years, incorporating UAVs to VRPs has received great attention in literature, and in practice by large corporations like Amazon and DHL. The incorporation of UAVs in the supply chain not only lowers operational costs, but also, decreases C02 emission and road traffic. Along with EVs, UAVS will be commonly used for door-to-door deliveries in the future and their combined utilization will establish a new era in logistics.

We introduce the Electric Vehicle Routing Problem with Drones (EVRPD), a Vehicle Routing Problem combining EVs and Drones. Despite their benefits, EVs and UAVs impose constraints which are not present in the traditional VRP. Charging function must be created for the vehicles and lots of details ought to be considered. Characteristics such as temperature and vehicle load are two of the factors proven to have great effect on the range, leading us to another problem, range anxiety. When planning routes for EVs, adjustments need to be made to account for visits to charging stations and long recharging times. The EVRP objective is to minimize the total operational costs. A mathematical formulation of the EVRPD is presented, along with an Ant Colony Optimization algorithm to solve it. New instances were created for this problem and preliminary results are obtained.

Supporting Economic Sustainability of Cruise Destinations in Greece and Cyprus

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Keywords: Cruise Destinations; Ports of Call; Local Economy; Cruise Supply Chain; Traditional Products

Cruise is the most important and economically intense form of nautical tourism, heavily contributing to the European Blue Economy (i.e. by $65.5 billion in 2019). Despite being heavily disrupted by the recent outburst of Covid-19, the introduction of new health protocols, both onboard and at the ports of call, is expected to contribute towards the restart cruise activities paving the way towards the gradual transition back to 'normal' conditions / operations.

The Mediterranean region continues to account for the 2nd most attractive cruise destination in the world, after the Caribbean, with almost 16% of the world cruise fleet being deployed there (pre-Covid). Within the respective cruise itineraries, Greek destinations hold a prominent position, while Cyprus is presenting, over the last year, remarkable growth after a period of low cruise traffic. Despite the attractiveness of those destinations, the contribution of cruise activities in local economies at the ports of call is very low, not balancing out in that way resulting externalities.

Considering also key recent trends affecting the cruise industry such as (a) the search of passengers for memorable and diverse experiences and (b) the greater use of technological solutions / applications both onboard the vessel but also at cruise destinations, providing personalized services to passengers tailor-made to their preferences, there is room for introducing innovative ideas that can provide new experiences to passengers whilst supporting economic sustainability at cruise ports of call.

To this end, a novel digital platform has been developed within the context of the NAYS project with the aim to promote local traditional products to cruise passengers thus integrating them into cruise supply chains for cruise companies adding for example a 'tasting' experience of Greek and Cypriot cruise destinations. Through this platform, local producers and suppliers can post their products that can be made available at different ports of call, and cruise passengers and companies (i.e. B2C and B2B) can place their orders to be delivered at the cruise vessel. A series of consultation activities with all relevant groups of stakeholders were undertaken for specifying the structure of the platform and services to be offered, which are currently (summer 2021) being pilot-tested. The latter activities are expected to evaluate the usability and user-friendliness of the platform and its features, and provide as a next step a series of recommendations to be up-taken during the preparation of its final version, so that the product to be commercialized at the

end of the project is tailored-made to users' needs. Interoperability with National Maritime Single Windows, that are still not operational in both countries, has been also foreseen so that nautical information can be retrieved and utilized within the platform for determining service windows and cut-off times for order placement.

Status of Renewable Energy Systems in the World and Prospects

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Keywords: Renewable; Energy; Climate Change

This presentation examines the current status of renewables in the world. The presentation starts with some facts about climate change, global warming, and the effects of human activities, such as the burning of fossil fuels on the climate problem. It then outlines of the status of renewables in the world, which includes their shares with respect to conventional fuel use for power and for electricity production alone, and their social dimension in terms of jobs created. Then the basic forms of renewables are examined in some detail, which include solar thermal, both for low and high temperature applications, photovoltaics, hydro power, onshore and offshore wind energy systems and biomass/biofuels. In all these the basic technology is presented followed by the current status, the installed capacity in the last decade, which reveals their upward trend, as well as the prospects of the technology and some new research findings.

Climate Change: Awareness and Responses of Indian Corporates

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Keywords: Climate Change; Corporate Responses; Sdgs; India; Sector And Industry Differences

The climate across the globe is going through major changes (NOAA, 2018; Pachauri et al., 2014; Solomon et al., 2007). Scientific evidence confirms that these changes have a direct correlation with human activity and according to many studies, businesses are to blame for bringing about a major share of these changes (Cook et al., 2013; Rosenzweig et al., 2008). India with its fast growth rate and consequent energy demands requires determined efforts from the major Indian corporates to meet the NDC targets committed by the country. Hence it is important to understand the current state of awareness and efforts made by the Indian corporates on this issue as well as the factors responsible for the corporate actions. This study uses published data and 52 indicators designed for the purpose, to understand the awareness and responses of top 60 Indian corporates to climate change and its impacts. The positive responses of the companies to the indicators were assessed in simple percentages and companies were ranked accordingly. The positive and negative responses were converted to 1 and 0 codes respectively for the rest of the statistical analyses. One-way ANOVA tests were used to find whether the difference between the groups is statistically significant at 5% level of significance. The results indicate that though most of the organizations are aware of climate change, the responses vary significantly among private and public sectors, different industry types, and also within the same industry. Private sector firms clearly outperform those from the public sector and manufacturing industries remain ahead of services industries, when it comes to climate action. We did a 2-cluster k-means clustering that yielded cluster-1 comprised of 38 companies with a mean positive response of 74.1% and cluster-2 of 22 companies with a mean positive response of 22.6%. The ANOVA done to compare the companies under the 2 clusters turned out to be statistically significant, with a very low p-value. We also found that the annual revenues and the profitability of the firms are positively correlated with the performance on the climate change indicators.

Towards the Optimum Combination of Decentralised Flexibility Assets in the Markets Creating Benefits to All the Actors in the Smart Grid Value Chain

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Keywords: Flexibility Platform; P2X; Flexibility Modeling

Since 2014, the strategy of the European Union has been clear: "we need to drive a clean, secure and efficient energy transition to face climate and energy challenges". This strategy has been reinforced by the strong commitment of the European Union towards the signature of the landmark 2015 Paris Agreement. This is also why the European Commission proposed in November 2016 an ambitious "Clean Energy for All Europeans" package and further strengthen with the "EU Green Deal". The EU is now in the process of updating its energy policy framework in a way that will facilitate the clean energy transition and make it fit for the 21st century. The new policy framework brings regulatory certainty and empowers European consumers to become fully active players in the energy transition and fixes new targets for the EU for 2030. Towards this direction, the increasing share of Distributed Renewable Energy Sources (DRES) in the energy grid has become key for the decarbonization of the European electricity system and thus for the achievement of the EU energy and climate change policy goals. Nevertheless, the variability and uncertainty of these distributed sources pose important risks and challenges to the stability and security of the European, national and local grids, but at the same time they open new opportunities to the energy value chain. This overall picture is completed by an emerging decentralized ecosystem where new energy systems, such as batteries, power to heat/cold, vehicle to grid and other storage solutions, are offering a large flexibility potential to the grid.
Taking into account the emerging needs in the electricity network, we propose a set of efficient, cost-effective, integrated solutions, to facilitate the optimum combination of decentralised flexibility assets, both on the generation (DER) side and on the demand side (V2G, power-to-heat/cold/gas, batteries, demand response), enabling all parties, including final prosumers, to offer their flexibility in the recently established markets creating benefits to all the actors in the smart grid value chain. A tool for flexibility managers is designed and developed to take advantage of the value of energy storage along with other demand flexibility resources towards the establishment of a holistic framework for flexibility extraction, profiling, forecasting, classification, clustering and management to serve different market and grid needs. The enhanced functionalities envisioned for this tool are planned to be tested for a long period (> 1 year) in 4 demo sites around Europe.

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Is the Level of Education a Relevant Factor influencing the Air Pollution Attitudes of the Countries? A EU-28 Case of Study

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Keywords: Sustainable Development; Emissions; Education; Attitudes; EU-28

The sustainable development represents one of the cornerstones of modern economies. The concept can be defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report, 1987), so this type of development implies to reduce in any way the environmental impact of different countries. The United Nations Conference on Environment and Development, held in Stockholm on 5 to 16 June 1972, can be considered the first proof of the global dimension of climate problems. However, the climate change is not recognized until the United Nations Framework Convention on Climate Change, adopted in May 1992, signed by more than 150 countries at the Earth Summit in Rio de Janeiro. With this landmark and with the purpose of designing the best policies to guarantee the needs of the present but also the needs of future generations, it is necessary to know what are the variables affecting the environment and, particularly, the air pollution. Previous research in the field have developed well known models such as the Environmental Kuznets Curves (EKC) or the STIRPAT model (Stochastic Impacts by Regression on Population, Affluence and Technology). These studies have analysed the influence of variables such as GDP per capita, population, energy intensity or technological readiness on the emissions to the atmosphere among countries around the world. To the best of our knowledge, the level of education has been one interesting factor that has not been deeply analysed in this type of research, although it may be considered an important factor influencing positively on the actions of the population of a country, and hence on pollution attitudes. The main contribution of this work is represented with the specification of an econometric model for the EU-28 countries, which studies the influence of relevant variables on the environment. Regarding the explanatory factors included, it deserves to be highlighted the inclusion of a new variable that represents the level of education of each country, which is created based on the Programme for International Student Assessment (PISA) results. With the introduction of this new variable, it has been analysed the role of the level of education as a relevant factor affecting the air pollution.

Study on Airflow and Temperature Distributions in a Data Center

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Keywords: Computational Fluid Dynamics; Data Center; Flow Field

In this study, the airflow and temperature distributions in a data center are examined numerically in details. The ANSYS Fluent is used to simulate airflow field and temperature profile. The main target is focused on the heat removal of servers in the data center under different operating conditions. This study adopts Model 1 and Model 2 of variation models. The rack in a data is taken to be the main body with cold and hot aisles and the heat recovery chimney extending from it. The Model 1 is a common approach involving rack heat dissipation with enclosed cold aisles, and open hot aisles for heat recovery. The Model 2 had an enclosed cold aisle and closed hot aisles for chimney-type heat recovery. This study also illustrates two cases of variations in geometry for the temperature tests. In Case 1, the length of the aisle is not increased and floor slab and raised floor ranges (0 m). In Case 2, the dimensions of each aisle are increased by half and the dimensions of floor slabs and raised floor are increased accordingly (0.3 m). In Case 1, the inlet area is smaller than those of the other two cases, causing the initial velocity to increase too fast, meaning the lower-level servers will not receive a sufficient volumetric flow rate, thus affecting the heat dissipation of the servers, while at the upper level, the excessive airflow will largely remove the hot spots at the rear of the servers; thus increasing the gradient of the temperate curve. The results show that the Case 2's size and 0.45 m of raised floor depth would help to distribute the airflow uniformity in the same rate. However, buoyancy effect does not affect the temperature variations in the rack. Secondly, Model 1 standard flow rate (1.44 m^3/s) provide better cooling efficiency than Model 2's low flow rate (0.72 m^3/s). Therefore, Model 1 is more suitable for rack cooling strategy. Finally, adding the front fans can provide better heat removal and flow field in the rack.

Competition of Aggregators in Local Energy Markets

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Keywords: Aggregators; Bi-Level Optimization; Local Energy Markets

In recent years, more energy is being generated locally by resources that are distributed across the distribution networks. Distributed energy resources (DER) comprise distributed generation (DG) units, energy storage systems (ESS) and demand response (DR) solutions. The ever increasing penetration of DER, especially that of renewable energy resources (RES), such as roof-top photovoltaics (PV), as well as the adoption of DR programs from flexible end-customers, has transformed distribution networks from passive to active. The active distribution systems (ADS) can manage the DER actively through advanced communication technology and achieve cost-effective operation of the distribution system [1]. This transition creates new technical challenges, yet brings forth financial opportunities for system operators, energy market participants and other entities such as aggregators [2].

Aggregators have recently attracted the interest in the field of power systems acting as mediators between system operators and demand-side. They represent and manage a group of end-customers and/or small-scale producers, i.e., owners of small-scale DG units. Aggregators offer adequate financial incentives to regulate the consumption and/or the production they represent. Such a regulation is strongly related to the demand-side flexibility (DSF) of end-customers.

Over the last years, aggregators are expanding their presence at the distribution level by offering flexibility services towards the management of ADS. Distribution system operators (DSO) take advantage of such services to improve the operation of the system and defer costly investments. For instance, according to [3], the implementation of DSF schemes can facilitate the penetration of RES in distribution systems. Distribution companies (DisCo), in turn, procure aggregators' flexibility services to deliver energy at end-customers with maximum profit. In that setting, the price-oriented management of DER by aggregators could be financially beneficial [4].

This paper introduces a novel one-leader multi-followers bi-level programming model for the procurement of flexibility services in a local energy market. The upper level problem is formulated to maximize the profit of a DisCo, while the lower level problem intends to optimize the profit of multiple aggregators. Two different types of aggregators have been modeled: a) load aggregators, each interacting with a group of end-customers, and RES-based aggregators, each managing a portfolio of small-scale renewable energy resources and energy storage systems. The diversified demand-side flexibility of end-customers is also examined by considering two types of load, residential and industrial. The model is tested in different distribution systems to demonstrate the financial benefits that arise, while the results conclude with a sensitivity analysis.

References

[1] S. Bahramara, A. Mazza, G. Chicco, M. Shafie-khah, and J. P. S. Catalão, "Comprehensive review on the decision-making frameworks referring to the distribution network operation problem in the presence of distributed energy resources and microgrids," Int. J. Electr. Power Energy Syst., vol. 115, p. 105466, Feb. 2020.

[2] K. Ponds, A. Arefi, A. Sayigh, and G. Ledwich, "Aggregator of demand response for renewable integration and customer engagement: Strengths, weaknesses, opportunities, and threats," Energies, vol. 11, no. 9, p. 2391, Sep. 2018.

[3] I. I. Avramidis, V. A. Evangelopoulos, P. S. Georgilakis, and N. D. Hatziargyriou, "Demand side flexibility schemes for facilitating the high penetration of residential distributed energy resources," IET Gener. Transm. Distrib., vol. 12, no. 18, pp. 4079–4088, Oct. 2018.

[4] P. Sheikhahmadi, S. Bahramara, A. Mazza, G. Chicco, and J. P. S. Catalão, "Bi-level optimization model for the coordination between transmission and distribution systems interacting with local energy markets," Int. J. Electr. Power Energy Syst., vol. 124, p. 106392, Jan. 2021.

Design of Transport Infrastructure with Respect to the Specific Features of Case Studies

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Keywords: Model-Size Reduction Techniques; Cluster Analysis; Infrastructure Transformation

Currently, the increasing emphasis is placed on the long-term sustainability of the supply and processing chain in all sectors. In addition to the economic aspect, the overall impact on the environment are often addressed. To implement appropriate changes and meet the set goals, support tools based on mathematical programming are widely used. These tools can provide appropriate insight into the issues addressed and draw attention to possible unfavorable conditions or overall inefficiency of operation. The main problems are location and allocation tasks, which are usually solved using flow in the network. For accurate results and their possible applicability, it is necessary to use a detailed infrastructure, which is modeled using graph construction. However, these tasks are fundamentally limited by extreme computational complexity if a real problem is addressed. In the case of thousands nodes with millions of edges, it is almost impossible to perform a calculation, where the non-linearity or integer variables are included. The computation can often be performed only on less detailed infrastructure, which is usually given by historical development or legislation. On the other hand, this structure does not reflect the specific conditions of the problem and the obtained results could be distorted and their usability can be considerably limited. It is therefore appropriate to deal with the design of own infrastructure. The aim is to create a changing detail of the transport infrastructure based on key elements in the system. The presented study introduces a proposal of a methodology for the design and reduction of transport infrastructure regarding an optimisation of network flow tasks. The principle of the procedure consists in keeping the finer detail of infrastructure in the vicinity of the monitored node and it is possible to have coarser detail with increasing distance. For this purpose, the transformation of the coordinates of the nodes is used, followed by the application of cluster analysis. Gradually, the k-means and hierarchical clustering algorithms are introduced, including their evaluation by silhouette. For the design of the transport network, the distances between municipalities and population are used. On the other hand, it is desirable to include other key factors such as production, capacity and taking into account multiple reference nodes, which will be the subject of consequent research.

Modelling Opportunities of Waste Production Quantities and Future Generation Rates

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Keywords: Waste Production; Forecasting; Prognosis; Waste Composition; Waste Modelling

The transition to more environmentally friendly energy and the circular economy entails interventions at all levels, from legislative to support campaigns or subsidy policies. Changes are already taking place in waste management, where the most significant trend is to maximize recycling and prevent waste from production. However, to set the milestones that the European Commission has attempted in the circular economy package to set sensibly, as much data on waste as possible must be known. This is mainly the amount of waste produced within municipalities for all types of waste. It is also crucial to know the composition of mixed municipal waste to understand what potential for sorting and further separation is still hidden or possible from the population behaviour perspective. In each state, some data are recorded as part of monitoring in state databases. However, they contain many errors, are not consistent and, most importantly, do not provide all the data. In addition, it is necessary to look for trends in the data to estimate the future production of individual components of waste and prepare the necessary processing infrastructure. The paper will discuss all the pitfalls related to the forecasting of waste production, the relationships and correlations between individual waste codes, the links between regions and methods of detecting extreme values. Operational research, statistical procedures, clustering and other methods will be used to gain insight into the details of waste management. All the mentioned procedures will enable better decision-making in the field of legislation, building the necessary infrastructure, both for the treatment and final treatment of waste. With regard to the composition of the waste, it is also possible to introduce new waste streams within separate collection containers. All this will also lead to the possibility of better evaluating and directing waste management towards meeting the European Union's recycling targets.

Profits and Access along Ghana's Charcoal Commodity Chain

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Keywords: Charcoal; Access; Power; Africa

Are lucrative charcoal markets in Africa reducing poverty for people in the trade? In spite of its economic significance, the extent to which charcoal income reduces poverty is debatable. This article applies commodity-chain analysis to Ghana's charcoal commodity chain to describe the characteristics of actors, and to quantify and explain the profits reaped by the different actors in the chain. We estimate that profits of US$66 million are generated annually. The distribution is highly skewed between and within actor groups, with 22% of profits reaped by merchants, who make up only 3% of the actors in the market. The majority of producers and retailers, by far the largest groups in the sector generate incomes below the national minimum wage. Women dominate the market in terms of number of persons involved. Women and men earn equal incomes at all levels of the market except at the production level, where men reap higher profits than women. People from several ethnic groups engage in the market, but members of the Sissala and Asante ethnic groups are the most frequently encountered ones throughout the chain. Improving equity along the charcoal chain will require breaking the interlocking credit-labor arrangement that enables merchants to have control over charcoal prices, and improving producers' access to urban markets. The paper makes policy recommendations in this regard.

Development of Sensible Heat Storage Material using Dune Sand, Clay and Ash Waste

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Keywords: Ceramic Ball; Dune Sand; Clay; Ash; Thermal Energy Storage Material; Thermocline; Concentrating Solar Power(CSP) Plant

The global demand for energy is growing and conventional resources like coal and petroleum are depleting. Renewable energy production through CSP is expected to play a crucial role in the near future. In this paper, available raw materials from West Africa have been used to develop ceramic for sensible heat storage. The mechanical and thermal properties of dune sand, clay and organic additives (ash waste from incinerator coal power plant) obtained ceramic balls have been investigated after being developed at 1000°C and

1060°C using sintering method. A muffle furnace was used. The specimens were dried within an oven at 105°C after being formulated by mixing sand, clay, ash and water. The total percentage mass of the all raw materials was supposed to be 100% for each formulation. The resulting ceramic density and porosity were determined using Archimed method. The obtained ceramics were compressed with a compression machine and thermally analyzed using Decagon devise KD2 Pro thermal analyzer. The specimens were submitted under thermal cycles at 610°C with heating rate of 20°C and mean cooling rate of 14°C after being hold one hour at 610°C. It was found that when the percentage weight of ash increased the porosity of the ceramic increase. Which has driven in the increase of the axial tensile strength reaching 3.5MPa for sand-clay ceramic. The ceramic balls with the required tensile strength were selected. From the axial tensile strength analysis only the ceramic balls formulate with 55% wt or 58%wt dune sand, 33%wt or 30% of clay and 12%wt or 30%wt of ash have been selected. Their volumetric heat capacity and specific heat capacity range respectively from 2.505$MJ.m^{-3}°C^{-1}$ to 3.105$MJ.m^{-3}°C^{-1}$ and from 1059.197 J/kg.°C to 1319.031 J/kg.°C; and thermal conductivity from 0.367$Wm^{-1}K^{-1}$ to 0.454$Wm^{-1}K^{-1}$ depend on firing temperature. Also the different specimens have undergone 60 thermal cycles without observing any crack. These properties allow envisioning the use as filler material for thermocline thermal storage systems.

Development of a Novel Compact Flat Plate Solar Collector Integrated with LHTES Tank: Finite Element Analysis to Evaluate Optimum Tank Insulation and Structural Analysis of the Supporting Base

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Keywords: Integrated Solar Collector; Thermal Analysis; Structural Analysis; Phase Change Material; Optimum Insulation Thickness

SolarKit is a novel, compact, flat-type solar collector integrated with latent heat thermal energy storage (LHTES) tank filled with paraffin phase change material (PCM). The collector is connected through a closed loop Heat Transfer Fluid (HTF) circuit with the tank. An open circuit connected to mains is used to produce domestic hot water (DHW). Both circuits are part of a heat exchanger, immersed in the tank of the PCM. During insolation, thermal energy is stored in the LHTES, which can be used to heat service water. For such applications, one of the most important factors of operation is the ability of the unit to retain the energy collected through the charging process and provide it in request. The LHTES tank is thermally insulated to minimize thermal losses. In this study, thermal analysis was performed to determine the optimum thickness of insulation to minimize the cost, the unit volume and thermal losses. Results of thermal losses, PCM temperature and heat transfer rate are presented and discussed, concluding that the optimum insulation thickness is 80mm. Also, the Solar kit base structure is analyzed as a 3D beam element metallic

frame using the standard displacement Finite Element Method (FEM). The same finite element model is employed for both static, wind, and seismic load cases. Using the analysis results, as well as the relevant post-processing analyses (stress and displacement checks), it is confirmed that all structural elements of the metallic base frame possess the appropriate strength and stiffness, to sustain all loading combinations (in both ULS and SLS conditions), with satisfactory safety.

Assessment of Wave Energy Solutions to Complement into a Hybrid System of a Floating Offshore Wind Energy Farm in the Aegean Sea

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Keywords: Blue Economy; Blue Energy; Wave Energy; Floating Offshore Wind Farms; Hybrid Systems; Aegean Sea

The present paper aims to present solutions that can push offshore wind energy towards the forefront of renewable energy production by incorporating additional wave energy at hand, while offering an answer to the energy requirements of the Aegean Islands; the latter mainly source their electricity from conventional hydrocarbon fueled generators. Wave energy is an alternative renewable energy source whose harvesting methods are still in their infancy. Due to that factor investment into wave power through Wave Energy Converters (WEC) has been slow and minimal compared to other renewables. A possible push towards investment could be the integration of wave energy converters into other renewable energy installations, in order to spark innovation and further optimization and streamlining of their manufacturing and operating processes. Offshore wind platforms seem the most prime for integration, as offshore energy benefits from mutual increased wind and wave power potential. In the Aegean Sea, albeit the very promising wind energy potential, proposals for offshore wind have presented difficulties due to Aegean's large water depth; with floating structures appearing as the ideal alternative to monopiles. Featured in this paper is a methodology for calculating the total life-cycle cost of a floating offshore wind farm while incorporating various WEC solutions, in order to assess their power potential and economic efficiency. Floating solutions are selected in the Aegean, as part of a push for clean power and Islands' energy independence. In addition, using appropriate software, several economic indices are calculated, based on which the economic viability of a hybrid floating offshore farm is assessed. The hybrid solutions studied are divided into structures where WECs can be retrofitted or others that require tight integration and must be pre-designed with wind-wave energy extraction in mind. Three potential areas for installation are investigated (offshore of Lemnos, Mykonos and Crete), coming to the conclusion that the most cost-effective and power abundant solution is presented in the area of Eastern Crete. The benefit of using a hybrid system is shown clearly. Indeed, the annual energy output increase can reach 15% while the cost increase is limited to approximately 7%, clearly indicating that offshore energy in the Aegean should move towards these beneficial hybrid systems.

Effect of ZnO Doped Phase Change Materials on the Efficiency of Photovoltaic Solar System

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Keywords: Photovoltaic System; Electric Efficiency; Copper Multi-Pipe Frame; ZnO Powder; PCMs

Currently, the photovoltaic (PV) has been emerged as a promising option for future electricity production. However, reduction in electricity production efficiency due to the increase of the module surface temperature seems to be one of the major challenges among others. In the present work, an experimental investigation is conducted to assess the power conversion efficiency (PCE) of a PV solar system integrated with copper multi-pipe frame filled with ZnO doped phase change materials (PCMs). The copper multi-pipe frame is designed and attached at the back of the used mono-crystalline silicon module in order to reduce the module surface temperature efficiently and to improve the heat transfer rate between the PCMs and the module. The tests were conducted at the University of Jeddah on 8th March 2021 at various local times for the systems with PCMs and ZnO doped PCMs with reference to the conventional silicon PV system. Solar meter, multi-meter, temperature sensor, digital anemometers are used to measure the sun irradiation, I-V curve, panel surface temperature and wind velocity respectively. Results show that a significant variation of module surface temperature with respect to time and PV solar systems. It is identified that the PV system integrated with ZnO/PCMs can represent the least module surface temperature along with the electric efficiency of 10.83%, filling factor (FF) of 86.69% and electrical performance of 49.92 W/m^2 at 12 pm. It is also identified that the overall PCM of the PV system employing with PCMs/ZnO has been increased approximately 12.34% as compared to that of conventional PV system. These findings demonstrate that multi-pipe cooling frame filled with ZnO/PCMs can effectively overcome the adverse effect of the increment of module surface temperature and thus, improves the PCE of the PV system.

Wave Power Projections for the 21st Century in the Black Sea

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Keywords: Renewable Energy; Wave Power; Climate Change; Spectral Wave Modelling; Black Sea

We carried out a 21st century projection study for the wave power as a promising renewable energy source in a semi-enclosed basin. To this aim, wave height and periods are modelled using spectral wave model SWAN throughout the 21st century in the Black Sea basin. The projections are based on 4.5 W/m^2 and 8.5 W/m^2 Representative Concentration Pathways (RCP) of two General Circulation Models (GCM). The models are Climate Model v3 (CM3) and Earth System Model v2M from the Geophysical Fluid Dynamics Laboratory (GFDL). To achieve the goal of projecting the wave data forced by the winds, surface wind speed data from the GCMs with the coarse resolution is subjected to a Two Layer RBF Downscaling method. The spectral model is run for the periods of 1979-2005 and 2020-2100 with a structured mesh over the Black Sea. The wave power potential is investigated spatially, and locally with spatially sparse points selected throughout the basin. Spatial maps of wave power are presented for five different year intervals, GCMs, RCP scenarios, and the respective seasons. Temporal changes in the wave power are investigated by the 21st century, in means of both monthly averages, yearly averages, and seasonal differences. The differences between two RCP scenarios are investigated, as well as the inter- and intra- annual variability between the two different wind speed data from GCMs. The results show that the average wave power in the basin fluctuates around 4 kW/m, and associated maximum wave power in means of monthly averages reach to 20 kW/m. Among the selected points, different patterns are observed between the climatic models and RCP scenarios. In general aspect, the wave power slightly increased for the GFDL-CM3 model for both RCP scenarios with respect to historical period. On the other hand, the wave power is decreased in the earlier the 21st century for GFDL-CM3 RCP 4.5 model, and then increased towards the end of century. On the other hand, the decrease in the earlier 21st century is not present in RCP 8.5 scenario. The spatial distribution of the wave power in the basin does not change according to projections, but the wave power differences with respect to historical period are ranging between +0.14 kW/m and -0.32 kW/m in means of basin averages."

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Institutional Factors in the Heart of the Renewable Energy Adoption in South Africa: A System Dynamics Approach

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Keywords: Institutions; Renewable Energy; Supply Mix; South Africa

The level of greenhouse gas emissions globally with its dire consequences on climate has intensified the efforts of many countries in proceeding with drastic changes in their supply mixes, recognizing that the power generation sector is the main contributor to air pollution (AlFarra & Abu-Hijleh, 2012; Apergis et al., 2010; Bellakhal et al., 2019). The flexibility and smaller initial capital investment requirements of the renewable energy option also suggest them as a solution to energy (in)security and energy poverty, particularly in developing countries. Even though, however, the transition towards renewable energies and "away" from fossil fuels is a given internationally, not all countries adopt the new technologies with the same speed. Cadoret and Padovano (2016) concluded that regardless of the institutional and policy environment where usually decisions on the supply mix are taken, the ideological orientation of the government and industrial lobbying can hinder the adoption of renewable energies. Bourcet (2020) adds that complentary to the policy and regulatory framework included in the literature, the political environment is also taken into consideration in some studies: certain projects benefit from political stability and sound regulatory frameworks. Nicolini and Tavoni (2017) showed that the ideological direction of the governments also plays a role in the magnitude and speed of renewable energy technology adoption.
The main purpose of this paper is to examine the impact of institutional and policy factors in the decision by countries to use renewable energy in their electricity supply mix. Firstly, the study will examine empirically the relationship between quality of institutions (variety of indicators) and adoption of renewable energies internationally. Subsequently, with the use of a basic system dynamics causal loop model, the study will examine the role of institutions in the renewable energy adoption for the South African electricity sector where the adoption has been considered relatively slow even though the country suffers from overall mismatches between supply and demand resulting in frequent power interruptions. The SD model's parameters will be derived from econometric partial equilibrium models to represent elasticities for the relationships between the variables of the model.

References

AlFarra, H. J., & Abu-Hijleh, B. (2012). The potential role of nuclear energy in mitigating CO2 emissions in the United Arab Emirates. Energy Policy, 42, 272–285. https://doi.org/10.1016/j.enpol.2011.11.084
Apergis, N., Payne, J. E., Menyah, K., & Wolde-Rufael, Y. (2010). On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecological Economics, 69(11), 2255–2260. https://doi.org/10.1016/j.ecolecon.2010.06.014
Bellakhal, R., Ben Kheder, S., & Haffoudhi, H. (2019). Governance and renewable energy investment in MENA countries:How does trade matter? Energy Economics, 84, 104541. https://doi.org/10.1016/j.eneco.2019.104541
Bourcet, C. (2020). Empirical determinants of renewable energy deployment: A systematic literature review. Energy Economics, 85, 104563. https://doi.org/10.1016/j.eneco.2019.104563

Cadoret, I., & Padovano, F. (2016). The political drivers of renewable energies policies. Energy Economics, 56, 261–269. https://doi.org/10.1016/j.eneco.2016.03.003

Nicolini, M., & Tavoni, M. (2017). Are renewable energy subsidies effective? Evidence from Europe. Renewable and Sustainable Energy Reviews, 74, 412–423. https://doi.org/10.1016/j.rser.2016.12.032

Winery Wastewater Treatment: Synergy Between Model and Experiment for Air Stripping Unit

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Keywords: Winery Wastewater; Chemical Oxygen Demand; Air Stripping; Process Modeling; Ethanol

Wineries use large volumes of water for equipment rinsing, during which is the water contaminated with ethanol, carboxylic acids, solids etc. This typically results in a high chemical oxygen demand (COD) and low pH, both of which exceed limits for discharge into surface waters, and in most of the cases, it is unacceptable even for regular wastewater treatment plants (WWTP). Biological methods are used widespread; however, they do not resolve the issue of high volumes and have only limited potential to re-use the water in the process.
Experiments with a multi-stage flash (MSF) evaporator showed encouraging results in wastewater volume reduction. Specifically, more than 90 % of water can be recovered as the distillate, whereas less than 10 % of the original volume remains in the concentrate, which makes MSF a promising minimum liquid discharge (MLD) technology. The obstacle to overcome is the amount of ethanol (and the corresponding high COD) present in the distillate stream. This requires a post-treatment method (e.g., reverse osmosis, stripping etc.) in order for the water to be reused in the process.
This work presents a successful case study on a stripping unit, which shows how to maximize the synergy of process modeling and experiments. A preliminary model, even with a relatively high degree of uncertainties, was used to determine an adequate flowrate of the stripping medium (2000 m^3 air / m^3 water) to reduce COD by around 50 %. Experimental results confirmed the validity of the model and helped identify some potential improvements (mass-transfer correlation selection, air humidity adjustment). The validated model was used to define a process envelope in case of possible scale-up in the future and also showed the need to use the air at elevated temperatures in order to achieve sub-1000 mg/l COD. This was confirmed by an experiment when multiple passes through the experimental stripping column, higher flowrate (2250 m^3 air / m^3 water) and an air temperature of 45 $^{\circ}C$ were sufficient to reduce COD below 1000 mg/l.

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Designing Integrated Equipment for 'Waste-to-Energy' Processes

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Keywords: Waste-to-Energy; Integrated Equipment; Computational Fluid Dynamics; Finite Volume Method

Global climate change forces the process industry to increase its effort to further reduce energy consumption, emissions, and waste production, thus leading to a strong push towards sustainability and more efficient use or disposal of the generated wastes. Modern approaches to the integrated and simulation-driven equipment design, based on efficient, up-to-date modelling and experimental techniques, represent a new trend in the development of process apparatuses and technologies. This trend, in turn, contributes significantly to the rethinking of the current and future industrial and process systems. Within this perspective, energy utilisation of wastes ("waste-to-energy") is discussed, where the processes and equipment tend to feature a much higher level of integration than is usual in other branches or industries. Such modern integrated equipment (MIE) generally offers improved efficiency and multifunctionality (i.e., multiple unit operations are aggregated into a single apparatus) [1]. Moreover, the implementation of MIE is often combined with process integration ("integration squared"), which ultimately leads to lower investment and operating costs and much more efficient and environmentally friendly operation of the respective technology. The design of MIE, however, is significantly more demanding in terms of quality and accuracy and necessitates the use of modern, usually tailor made (in-house) computational tools. Typical examples are various fast, CFD-based fluid flow and heat transfer prediction software tools providing optimisation functionalities in terms of fluid flow distribution, which considerably influences equipment operation. One such tool (a Finite Element Method-based one) was discussed by the author at ESCC 2020 [2], and the progress made to date in developing this tool is briefly mentioned. Then a different, Finite Volume Method-based software tool is presented, which is the main focus of this contribution.

References:

[1] Jegla et al., Opportunities and challenges in the development of modern integrated equipment for waste-to-energy units. In: Proc. ESCC 2020, August 24–27, 2020, Skiathos, Greece, article ID Q-20-2018.
[2] Turek et al., Fast, approximate analyses of heat transfer and fluid flow using Finite Element Analysis. In: Proc. ESCC 2020, August 24–27, 2020, Skiathos, Greece, article ID Q-20-2015.

Recovery of Secondary Raw Materials from Industrial Waste Water

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Keywords: Waste Water Treatment; Recycling; Secondary Raw Materials; Phosphorus; Nitrogen

The recovery of secondary raw materials from waste water is an important and very current part of waste water treatment process, especially due to the increasingly stringent environmental policy on waste water discharge and also existing shortages in natural nutrient reserves. Equally important is environmental protection as these nutrients can often lead to water bodies pollution events such as eutrophication. Notably, industrial processes produce a large amount of waste water, often containing environmentally hazardous compounds.

Industrial waste water very often contains a large amount of nutrients – particularly phosphorus (P) and nitrogen (N). These two nutrients are both crucial for living organisms, as they are essential components of nucleic acids, amino acids, and chlorophyll. Therefore, both play critical roles in plant growth and food supply as the main components of fertilizers.

Nutrient recovery works on the principle of 3R's: reduce, reuse and recycle. Many physical, biological, and chemical approaches to recover P and N from wastewater have been developed, including chemical precipitation, crystallization, adsorption and ion exchange processes, membrane processes, electrochemical processes, and biological processes.

For example, waste water from biogas plants and industrial laundries is rich in nutrients and therefore is deemed as a source for the recovery of phosphorus and nitrogen. For that reason, these two types of industrial waste water were chosen for a more detailed study of the potential to reduce pollution of the environment as well as lower the demand for these nutrients. One of the possible technology for phosphorus and nitrogen recovery is struvite precipitation. Struvite is an effective slow-release fertilizer that could replace fertilizers produced from phosphate rock. Because of this, the paper will provide an in-depth description and analysis of the precipitation mechanism. Besides, chosen methods will be discussed in more detail, focusing on chemical and physical properties influencing the nutrient's recovery. Also, the energy intensity and efficiency will be examined, as well as its future prospects and applicability on an industrial scale.

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Anaerobic Stabilization of Electrochemical Sewage Sludge

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Keywords: Exfoliated Biofilm; Methane Fermentation; Sludge Stabilization

The demand for vegetables, especially tomatoes, increases continuously all over the world. The global production of tomato is estimated at 100 million tons. This high production rate is possible thanks to the use of soilless cultivation system, enabling producing high yields of top-quality vegetables on a smaller area than compared to traditional field crops. In this system, fertilization and irrigation of plants is carried out by supplying the root zone with an aqueous solution of fertilizers. In order to reduce the adverse effect of nutrient concentration, which is the result of greater transpiration of water than the uptake of nutrients by plants, an additional amount of nutrient solution is used, which is referred to as overflow or drainage water. In soilless cultivation of tomatoes on mineral wool, the overflow can be as much as 50% of the nutrient supplied, which contributes to a loss of nutrients. On a global scale, the most common are open fertilization systems for plants, where crude drainage waters are discharged into the environment, polluting groundwater and surface waters with nitrogen and phosphorus compounds. Earlier studies of the authors of this presentation showed that effective treatment of drainage waters was feasible thanks to the simultaneous use of bio-electrochemical processes, where nitrogen compounds are removed as a result of autotrophic and heterotrophic denitrification, and phosphorus compounds as a result of electrocoagulation. It is also worth noting that, according to the literature, the sludge generated during electrobiological treatment features lower hydration and very good sedimentation properties.

The presented study aimed to determine the degree of sludge stabilization in methane fermentation of a biofilm generated during the treatment process of wastewater from soilless tomato cultivation. Horticultural drainage was treated in an electrobiological disc contactor with an active volume of 2 L, at four densities of direct current: R1 - 0.63 A/m2, R2 - 1.25 A/m2, R3 - 2.5 A/m2, and R4 - 5 A/m2. Wastewater hydraulic retention time was 24 h, and sodium acetate was used an external carbon source in a C/N dose of 1.

The sludge produced during electrobiological treatment of wastewater was subjected to methane fermentation using an AMPTS II analyzer (Bioprocess Control, Sweden). The composition of biogas was measured using a gas chromatograph connected to a thermal conductivity detector (GC-TCD) (Agillent 7890 A).

The methane fermentation produced the following biogas yields: R1 - 277.4±4.3 cm^3/g d.o.m., R2 - 271.5±2.3 cm^3/g d.o.m., R3 - 270.4±7.6 cm^3/g d.o.m., and R4 – 129.7±39 cm^3/g d.o.m. The degree of sludge

fermentation ranged from 16.5% (R1) to 9.6 % (R4). Study results indicate that the biogas potential and fermentation degree of sludge produced in electrobiological disk contactors decreased along with electrical current density increase.

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Valorization of Glycerol through the Aqueous Phase Hydrogenolysis Process to Obtain Value-Added Products

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Keywords: Biodiesel, Glycerol, Ni/Al-Fe Catalysts

The use of biomass as a renewable organic resource is an alternative to oil. Currently, the high production of biodiesel is due to an increase of a result of global environmental concerns and the reduction of fossil fuels. However, the production of biodiesel generates glycerol as by-product, for every 10 tons of biodiesel produces around 1 ton of glycerol. This context creates a surplus of glycerol that could negatively affect the bio-combustible economy. Therefore, several processes have been investigated to valorise glycerol [1-3]. In the bio-refinery context, a challenge for engineering is transforming glycerol into value-added products. Fig. 1 illustrates the biodiesel production cycling towards value-added chemicals from glycerol as by-product.

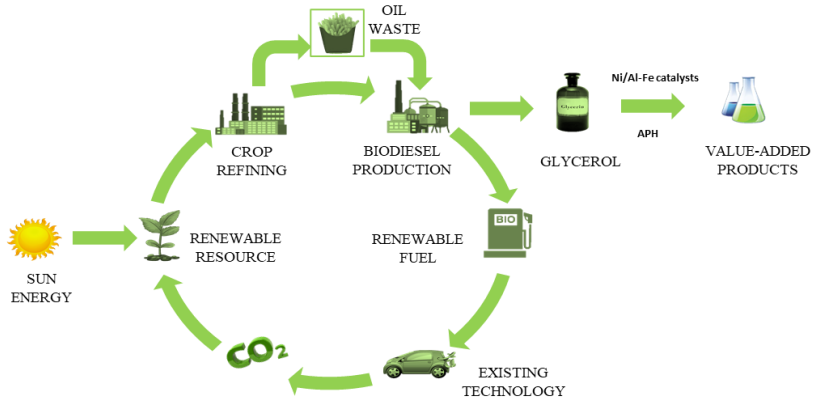

Fig. 1. Biodiesel production cycling towards value-added chemicals from glycerol as by-product.

The present work studied aqueous phase hydrogenolysis (APH) of glycerol over Ni/Al-Fe catalysts without external hydrogen addition. APH is a catalytic process performed at moderate pressures (20-50 bar) and quite low temperatures (200-250 ºC) [4], allowing the production of gases and liquids from a renewable feedstock. This work focused on the production of value-added liquids such as 1,2-propanediol, ethylene glycol and acetol, minimizing the generation of gases. As this process does not require external addition of hydrogen, it is a less expensive and safer process than the conventional hydrogenolysis that needs its contribution. In addition, it was performed in a continuous system which is useful due to the greater production potential on an industrial scale.

1,2-propanediol is a major commodity chemical that is mainly used in unsaturated polyester resins, functional fluids, liquid detergents, and cosmetics, among others. Ethylene glycol is an important bulk chemical with applications in antifreeze and as raw material for the manufacture of polyester fibres. Acetol is used in food, cosmetics, textile industries and so on [5, 6].

With this background, this work studied the effects of the molar ratio of Al/Fe during the APH of glycerol. The different Ni/Al-Fe catalysts were prepared by co-precipitation method as described by Raso et al. [6] keeping the Ni content constant at 28 molar %. The molar ratio of Al/Fe was changed in the order 1/0, 3/1, 1/1, 1/3, 0/1. These catalysts were calcined at 500 ºC and were tested during 3 h at 34 absolute bar and 227 ºC using a solution of 10 wt.% of glycerol in distilled water, after reducing them. Furthermore, the present work examined the effect of the calcination temperature on the catalyst which gave the best performance in the APH of glycerol, Ni/Al3Fe1. The calcination temperature was varied with values of 500, 625 and 750 ºC.

The results of APH of glycerol will show the conversion of glycerol and the carbon selectivity to value-added liquid products. Catalysts' characterization before and after the reaction will provide information about the properties of the catalysts and their stability.

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Disintegration with a Pulsed Electric Field and its Effect on Methane Yield from Grass Silage

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Keywords: Methane Fermentation; Biogas; Pre-Treatment; Pulsed Electric Field

Priority has been given in recent years to the development of technology for organic waste (particularly biomass) processing to obtain energy carriers. Vascular plants, which comprise lignocellulose complexes, are often used as a substrate in biogas production. Such complexes require pre-treatment to increase the biogas yield per biomass unit since they are difficult to decompose due to their structure. Therefore, interest in research into methods for plant biomass conditioning is steadily growing.
This study aimed to determine the effect of the substrate pre-treatment with a pulsed electric field (PEF) on the methane yield. Grass silage was used as the lignocellulosic substrate. To this end, cut-up grass silage was hydrated to 95% and subsequently pre-treated in a PEF disintegration plant. The electric field distribution in the coaxial disintegration chamber was 38.61 kV/cm - 11.66 kV/cm at a frequency of 5 kHz. The experiment was divided into eight variants, according to the time of disintegration by PET. Since the purpose of disintegration is to damage the cell membrane or wall in the raw material, it can result in releasing intracellular organic compounds to the substrate liquid phase. Therefore, the extent of cell damage can be determined, for example, by using a total organic carbon (TOC) assay. Methane fermentation of the samples was conducted in an AMPTS II analyser to determine the biogas potential.
TOC in the liquid phase of feedstock for methane fermentation was analysed to determine the effect of a pulsed electric field on lignocellulosic material. Samples were analysed with a Shimadzu TOC analyser before and after the disintegration process. The initial TOC content in the grass silage was found to be 3126 ± 56 mg/dm^3. The greatest increase was noted after seven minutes of pre-treatment, when the average TOC content reached 3560 ± 64 mg/dm^3. The analysis of the grass silage biogas potential showed the biogas production rate in a sample not subjected to pre-treatment to be 448.94 ± 20.26 cm^3/g VS. The highest biogas yield was achieved in a sample pre-treated for seven minutes (535.57 ± 23.16 cm^3/g VS). The methane production rate from the control sample was 303.96 ± 13.68 cm^3/g VS and 364.95 ± 21.75 cm^3/g VS from the sample pre-treated for seven minutes.
The results of the research aiming to determine the effect of lignocellulosic material disintegration with a pulsed electric field show that it increases the organic compound content in the material liquid phase. Examination of the disintegration effectiveness by a biogas potential analysis also showed that pre-treatment with a pulsed electric field increased the biogas yield from lignocellulosic material.

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Use of a Pulsed Electric Field in the Pre-Treatment of a Lignocellulosic Substrate Before Methane Fermentation

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Keywords: Pulsed Electric Field; Lignocellulosic Biomass; Disintegration; Methane Fermentation

Biogas production in methane fermentation is a complex process which requires optimisation. One solution that can be applied is biomass pre-treatment before fermentation. It is assumed that proper technological pre-treatment of the substrate can considerably increase the methane fermentation efficiency. Currently, agriculture produces large amounts of organic waste in the form of "lignocellulosic biomass". Using this type of material directly as a substrate or a co-substrate for a biogas plant is difficult because of a high content of non-decomposable lignin. Pre-treatment is a key element in lignocellulosic biomass use. The application of pulsed electric field (PEF) is one of the biomass pre-treatment methods. A pulsed electric field exerts its effect by inducing short electric impulses at a specified time. A pulsed electric field can damage, rupture or permeabilise (increase the permeability of) the cell membrane of microorganisms.
The study aimed to determine the effect of disintegration with a pulsed electric field on biogas production from poultry manure.
The substrate was ground and hydrated to 95% before pre-treatment with PEF. The PEF disintegration chamber was co-axial, with the electric field distribution of 38.61 kV/cm - 11.66 kV/cm at the impulse frequency of 5 kHz. The research was divided into eight variants for different hold times in the disintegration chamber. In order to determine the impact of pre-treatment with PEF on the substrate cells, the total organic carbon (TOC) content in the liquid phase was determined before and after the disintegration. The substrate pre-treated with PEF was subjected to methane fermentation with an AMPTS II (Bioprocess Control) analyser to determine the biogas potential.
The analysis of TOC content in the control sample, not subjected to disintegration with PEF, showed its initial content in the substrate with chicken manure to be 1923 ± 94 mg/dm^3. The largest TOC content was noted in a sample disintegrated for 5 minutes – 2252 ± 59 mg/dm^3. The biogas production rate in a sample not subjected to pre-treatment was 307.29 ± 16.71 cm^3/g VS. The highest biogas production rate was achieved in the sample pre-treated for 6 minutes – 366.99 ± 17.37 cm^3/g VS. The methane yield from the control (no pre-treatment) sample of chicken manure was 210.42 ± 9.70 cm3/g VS, and 248.90 ± 11.38 cm^3/g VS from the pre-treated sample.
The study showed that the pre-treatment of a lignocellulosic substrate with a pulsed electric field increased the organic compound concentration in the liquid phase of the substrate but also increased the biogas production rate.

The research was funded by the National Centre for Research and Development as part of the project entitled “Development a lignocellulose biomass disintegration technology using a pulsed electric field” LIDER/8/0026/L-9/17/NCBR/2018. Subsidy amount: PLN 1,166,250.00.

Toxic Metals in Seaweeds from a North Atlantic Ocean Region (Tenerife, Canary Islands) - A Sustainable Production Area of Edible Seaweeds

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Seaweeds are increasingly common as food in western countries. However, most of the edible seaweeds traded in Europe are imported from Asian countries. The increased consumption of seaweed offers the opportunity to implement sustainable edible seaweed production systems in European countries. The coasts of the Canary Islands could be a suitable area for the controlled cultivation of edible seaweeds. Seaweeds are organisms able to absorb and accumulate toxic metals with the consequent health risk and, for that reason, it is necessary to determine the content of toxic metals in seaweeds to decide whether the selected areas may be optimal for growing edible seaweeds. The objectives of this study are i) to determine the toxic metal content in seaweeds collected from different areas of the Tenerife island, and ii) to propose the areas to set a sustainable production of edible seaweeds considering. The toxic metals content (Al, Cd, Cr, Pb, Hg) were determined in 158 samples of different seaweed species (Halopteris scoparia, Padina pavonica, Sargassum fluitans, Cystoseira spp., Haliptilum virgatum, Asparagopsis spp., Liagora spp., Dasycladus vermicularis, Ulva spp., Enteromorpha spp.) from four areas of the island of Tenerife (Poris de Abona, El Socorro, La Punta de Hidalgo) by ICP-OES (inductively coupled plasma optical emission spectrometry) and GF-AAS (graphite furnace atomic absorption spectrophotometer). Al is the most abundant toxic metal, standing out in the Asparagopsis spp. (2.88 g Al/kg dry weight). However, there is not any legal limit for Al. The highest Pb levels (3.92 mg/kg dw) and Cd (0.24 mg/kg dw) were recorded in P. pavonica and Cystoseira spp., respectively. The Hg level was lower than the limit of quantification of the method in all samples. Cd levels are under the legal limit set by the legislation. According to the collection areas selected, Poris de Abona, located in the south of the island, is the most polluted area and, consequently, seaweed cultivation is not recommended in this area. The statistical analysis has detected significant differences ($p < 0.05$) in the toxic metal content between the collection areas. Comparing the data obtained in this study

with the data recorded by other authors who analyze these toxic metals in algae from other geographical regions, it is estimated that the coast of Tenerife could be a suitable place for the sustainable production of edible algae. Pollution off the Canary Islands' coasts is low, due to the absence of industrial emissions. However, this study will continue to expand the collection areas of the Canary Islands as well as the determination of other metals and elements of interest.