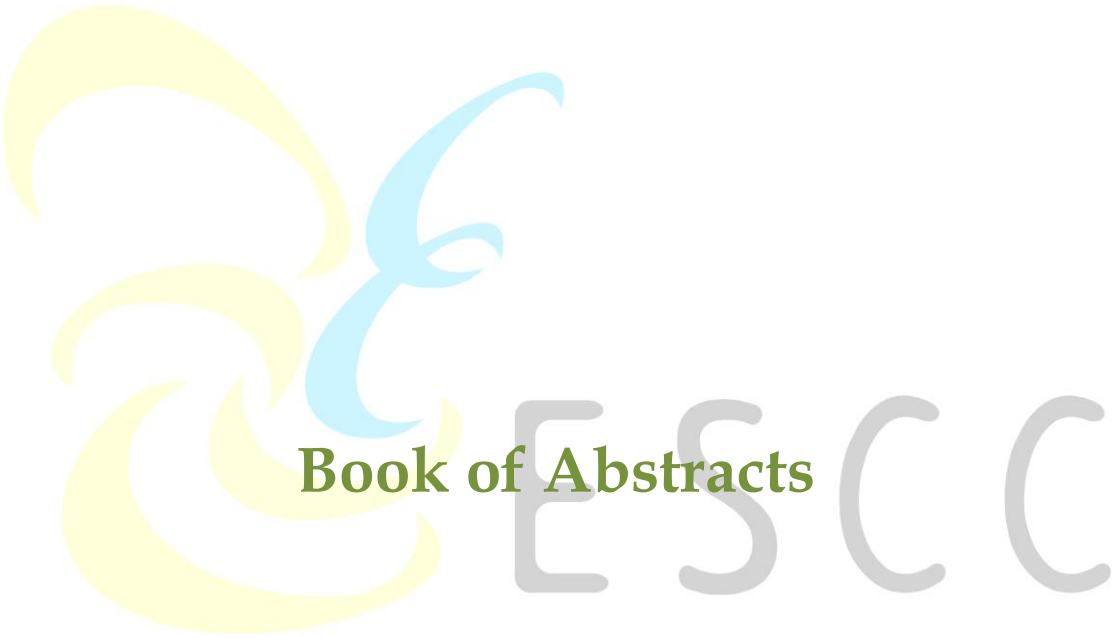
4th International Conference on "Energy, Sustainability and Climate Change"

ESCC 2017



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Contents

EU 2050 energy strategy towards sustainable energy systems

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Keyworkds: Energy Strategy

Historically, the structure of power systems was driven by an overall design philosophy developed to support large-scale generation technologies. The real-time control of distribution network is resolved through the robust specification of primary network infrastructure and hence, these networks traditionally operate as passive systems. There are two main developments that may radically change this conventional philosophy of electricity system operation and development. Firstly, during the past years, the EU has been deploying significant amounts of renewable technologies. Secondly, the EU generation, transmission and distribution infrastructure has approach the end of its useful life. The above developments open up the question of the infrastructure replacement strategy for which distributed generation and smart grids will become a key part. In addition, no real attempt has been made yet to optimize the operation and development of the future power systems as a whole. In order to address this, renewable and storage technologies will need to take over the responsibilities from large conventional power plants and provide flexibility and controllability necessary to support secure system operation. In this work, the EU long term energy strategy towards 2050 is presented and an optimistic scenario of achieving 100% sustainable EU energy system is discussed. Estimates regarding the associated energy cost are also presented.

Strategic Bidding for a Price-Maker Hydroelectric Producer

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Gregory Steeger & Timo Lohmann

Keyworkds: Hydroelectric producer

In bid-based markets, energy producers seek bidding strategies that maximize their revenue. In this talk, we seek the maximum-revenue bidding schedule for a single price-maker hydroelectric producer. We assume the producer sells energy in the day-ahead electricity market and has the ability to impact the market-clearing price with its bids. Our approach models the price-maker hydroelectric producer's bidding decision via a combination of Stochastic Dual Dynamic Programming and Lagrangian relaxation. In this framework, we dualize the water balance equations, allowing an exact representation of the non-concave immediate revenue function, while preserving the concave shape of the future revenue function. We model inflow uncertainty and its stagewise dependence by a periodic autoregressive model. To demonstrate our approaches' utility, we model Honduras' electricity market assuming that the thermal producers act as price takers and that one price-maker hydro producer operates all of the hydroelectric plants.

The elemed action - Electrification as the key to sustainable mobility

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Keywords: Maritime Transportation

A smart grid approach in conjunction with excess renewable electricity create an excellent environment for hybrid ships and battery installations applications. The elemed action under the Connecting Europe Facility framework aims to pave the way to a zero emission marine future, minimizing impact both to ports with the use of cold ironing but also densifying short sea connections with shore produced electricity used as a source of propulsion. This latter activity intends to analyze current and forthcoming technologies and produce an optimum size and design vessel concept that will be serving key joints between the core and comprehensive network nodes in the Eastern Mediterranean as well as short connections in the greater Greek Archipelago. It is envisaged that renewable potential and edge technology uptake, create synergies vital to the economic growth and the establishment of short island interconnections in a manner that no other synergy has attained so far. In this presentation the experience, features and methodology of the vessel concept optimization or the development of a modern, supportive framework are presented as key steps to a global project pertaining to the extensive use of electricity as an alternative fuel in the marine sector.

A Problem of Non-target Convergence Methods

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Keywords: Linear and Nonlinear Optimization

Nelder-Mead (NM) simplex algorithm applies a non-target convergence method. The method occasionally converges to a non-stationary point. In other words, the method has a premature convergence problem. McKinnon devised a family of functions and a special initial simplex. The device prolongs search duration. By using the device, we found the cause of the problem. Five McKinnon functions were tested by the NM simplex minimization with a non-target convergence method. The tests are based on following ideals: Optimization is competition among speeds (represented by durations). Under the McKinnon device, an optimization has 4 durations, RFIC, "close to", "escape", and "found". The first three constitute "search" duration. The steps required for convergence constitute convergence duration. A non-target convergence method converges regardless of any minimum. In other words, the non-target convergence method can stop a simplex in any duration. The outcome depends on speed competition between search and convergence. A quantitative example is presented. The RFIC, "close to", and "escape" durations were measured and compared to the duration of non-target convergence. For the McKinnon function with $\tau = 1$, the convergence duration was 60 steps. The simplex passed the RFIC and "close to" durations, entered to "escape" duration and stopped at an "escape" non-stationary point with the best function value 1.75x10-4. For the function with $\tau = 1.5$, the convergence duration was 50 steps. The simplex passed the RFIC duration, entered to "close to" duration and stopped at a "close to" non-stationary point with the best function value 1.80x10-6. For the function with $\tau = 2$, the convergence duration was 45 steps. The simplex also passed the RFIC duration, entered to "close to" duration and stopped at a "close to" non-stationary point with the best function value -1.40x10-7. These three are hard functions. Their simplexes were finally stopped at non-stationary points. For the function with $\tau = 2.5$, the convergence duration was 110 steps. The simplex passed through the RFIC, "close to", as well as "escape" durations and stopped in the "found" duration with the best function value -0.250. For the function with $\tau = 3$, the convergence duration was 88 steps. The simplex also passed through the RFIC, "close to", "escape" durations and stopped in the "found" duration with the best function value -0.250. The last two are easy functions. Their simplexes finally found the target minimum. In fact, the measurements vary with experimental conditions, but the rule is the same: if convergence duration is shorter than search duration, then the simplex stops at a non-stationary point. This rule is supported by succeeding experimental results: removing a non-target convergence method out of NM simplex algorithm and replacing the non-target convergence method by a target convergence method. If NM simplex optimization can eliminate premature convergence problem by removing or replacing a non-target convergence method, then the rule is confirmed.

Small-scale biomass gasification and power generation combined with carbonization/briquetting pretreatment

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Keywords: Renewable Energy

A portable and small-scale biomass gasification system has a potential for use in damaged areas by natural disasters (earthquake, flooding, Tsunami, etc.) or un-electrified rural areas in developing countries. However, the available feedstocks are usually high moisture content ones with different size, shape and properties. Therefore, some pretreatments are essential for efficient gasification of these feedstocks. In this study, woody biomass samples were first carbonized/torrefied by a carbonizer without usage of electricity. Then the carbonized/torrefied biomass were crushed and molded into briquette shape to be supplied into a fixed bed updraft gasifier. The syngas produced in the gasifier was first cleaned up by physical tar removal processes (the oil scrubbing, the centrifuge misty tar collection and the char bed adsorption) and was then supplied into a gas engine with 30kW electrical output. In the present work, some detail results on the carbonization/torrefaction process, the briquetting process, the gasification process, the gas clean-up process and the gas engine operation are presented. Then the mass balance and the energy balance of the total system is analyzed to show the self-sustainability of this system. This work was supported by Innovative Science and Technology Initiative for Security, ATLA.

Kalman filtering and classical time series tools for global radiation prediction

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Keywords: Renewable Energy

In this work, we propose intuitive methodologies based on the Kalman filter use, able to predict a global radiation time series without the need of historical data. The accuracy of these methods is compared to other classical data driven methods, for different horizons of prediction and time steps. The proposed approach shows interesting capabilities allowing to improve quasi-systematically the prediction. For one to ten hour horizons Kalman model performances are competitive in comparison to more sophisticated models such as ANN which require both consistent historical data sets and computational resources.

Potential conflict zones in Barents Sea

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Keywords: Optimal Control

As a result, of the global warming the situation in the Barents Sea leads to several important consequences. Firstly, oil and gas drilling becomes much easier than before. Therefore, it can lead to discussions on disputed shelf zones where the deposits are located, especially near to Norway-Russia sea border. Secondly, oil and gas excavation leads to potential threats to fishing by changing natural habitats, which in turn can create serious damage to the economics. In this work, we constructed a model, which helps to highlight potential conflict areas, analyze preferences of the countries interested in fossil fuels and fish resources. As a result, we hope, that our model will reveal potential conflicts zones.

Characterization and pyrolysis kinetics of Thai Napier grass and agricultural residues

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Keywords: Bioenergy

Napier grass, cassava stalk and rice straw are considered as potential biomass resources to implement the energy strategy of Thailand. Their thermal pyrolysis was studied by means of a thermogravimetric analyzer. A single distributed activation energy model (single DAEM) and a multi distributed activation energy model (multi DAEM) were applied for kinetic modelling and simulation, assuming the reaction order n=1 and n≠1. The results showed that the multi DAEM model described well the experimental data with higher fitting quality. The assumption of n≠1 was unfavorable since it denoted the complexity of thermal decomposition process. The extracted kinetic parameters are in good agreement with literature.

Germany's Energiewende: A Tale of Increasing Costs and Decreasing Willingness-To-Pay

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Keywords: Energy & Environment

This paper presents evidence that the accumulating cost of Germany's ambitious plan to transform its system of energy provision -- the so-called Energiewende -- is butting up against consumers' willingness-to-pay (WTP) for it. Following a descriptive presentation that traces the German promotion of renewable energy technologies since 2000, we draw on two stated-preference surveys conducted in 2013 and 2015 that elicit the households' WTP for green electricity. Two models are estimated, one based on a closed-ended question framed around Germany's target of 35% renewable energy in electricity provision by 2020, and the other on an open-ended format that captures changes in WTP over time. To deal with the bias that typifies hypothetical responses, the models distinguish respondents according to whether they express definite certainty in their reported WTP. The results from both models reveal a strong contrast between the households' general acceptance of supporting renewable energy technologies and their own WTP for green electricity.

Achieving sustainability in transport through the novelties of the 100% electrically powered ferry

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Keywords: Transportation and Energy Efficiency

Ferry services in the EU and around the globe are facing (among others) the challenges of increasing energy prices, and of the demand for renewable energy-efficient sources. In other words, they have to provide affordable, sustainable and low-emission transport services. These challenges are particularly acute in the cases of islands and other isolated communities. Ferries for both passengers and cars are popular especially in Europe, where more than one third of the world fleet operates. Compared to the rest of the world, Europe is extremely ferry intensive with two main markets; Northern Europe/the Baltic and the Mediterranean. As ferries have a long life span and since energy efficiency has not been a focal area until recently, many energy inefficient ferries are currently in operation in Europe. The majority of European ferries are actually older than 20 years. The European fleet is old and in need of newer, more energy efficient and less CO2 emitting and polluting types. In the attempt to address these needs, the E-ferry Project comes into the picture. Co-funded under the Horizon 2020 Programme, with duration of 4 years, the Project aims to support and promote energy efficient, zero greenhouse gas emissions and air pollution free waterborne transportation for island communities, coastal zones and inland waterways in Europe and beyond. This will be achieved through the application of an extremely energy efficient design concept and the demonstration of a 100% electric, emission free, medium sized ferry for passengers and cars, trucks and cargo in full scale operation on longer distances than previously seen.

E-ferry builds on the findings and recommendations from prior investigations of this field, proving the feasibility of the concept and indicating significant potential impacts compared to conventionally fuelled ferries operating on the same medium range routes, namely energy savings up to 50%, annual emission reductions of approximately 2,000 tons CO2, 41,500 kg NOX, 1,350 kg SO2 and 2,500 kg particulates. E-ferry will have the largest battery-pack ever installed in a ferry with a record breaking high charging power capacity. The innovative novelties of the E-ferry design concept and expected impacts addresses flaws in current state-of-the-art by demonstrating a concept based on optimised hull-shape, lightweight equipment and game-changing battery packs. To validate and prove the feasibility and cost effectiveness of the concept to the industry and ferry operators the new vessel will be demonstrated in real-life conditions on the Soeby-Fynshav (a) and Soeby-Faaborg (b) connections in the Danish part of the Baltic Sea.

Integrated solar flat plate collectors and passive solar floor heating in buildings

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Keywords: Energy Systems

Floor heating systems allow heat to flow slowly in a natural way from the floor upwards. Hence, the residents feel more comfortable through the temperature uniformity over the entire floor and the hot floor and the less hot environment.

Thermal mass integrated to the floor can act as a thermal reservoir that can store the solar gains of the day, which can be used to cover the heating needs of the building under certain climate conditions. In this study the foundation concrete in new buildings is examined as a storing material, where the heat gains of a flat plate collector array on the south wall are driven and accumulated.

First a model building, typically insulated and with walls facing the four cardinal points, is chosen for the study. The south wall area is assumed to be covered with Integrated-Solar-Flat-Plate Collectors, with water being circulated with a pump between the collectors and the foundation concrete when its temperature exceeds 40°C. A simulation model for the chosen regime, built in TRNSYS software, computes hourly results of the collected solar energy and the building thermal load under the climatic conditions of Limassol, Cyprus.

Then the hourly results of TRNSYS are used as input for simulations in COMSOL Multiphysics software. The solar energy collected is directed for storing in the foundation concrete. After an initial time priming, the foundation's temperature becomes sufficiently high to provide the daily heating load of the building.

Finally, more simulations are executed to examine the effect of parameters, such as thickness of the concrete, amount of heat available and that stored, as well as the controlling technique. Results are given as to under which conditions the system chosen can cover completely the heat requirements of the building and provide thermal comfort during winter in the climatic conditions considered here.

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The effect of CO2 and the sun on global climate

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Keywords: Greenhouse Gas Emissions

It is a fact that the global temperature has increased over the last century and this is explained through two schools of thought of opposing theories. The first and most popular theory claims that the prime factor for the recent temperature increase is the release of greenhouse gases – mainly Carbon Dioxide (CO2) – through anthropogenic activities. As there are other factors affecting the global temperature, like changes in solar activity, cloud cover, ocean circulation, etc., the second theory claims that it is the Sun's activity that has caused the recent warming.

In this study the effect of the greenhouse phenomenon and CO2 on global climate is discussed. It is suggested that numerical models lacking adequate knowledge of fundamental related-factors cannot be used to extract thorough conclusions. This is demonstrated through a simple comparison between estimates of the forecast for global temperature increase obtained by various independent studies. No obvious correlation exists between the global temperature and the CO2 atmospheric concentration if one makes observations though the geological aeons. Moreover, physical observation on other planets like Mars and Venus, demonstrates the effect of the atmospheric-CO2 partial pressure on the temperature of the atmosphere.

On the other hand the role of the sun in global warming has been greatly underestimated. Yet scientific evidence shows that the orbit of the earth and the Milankovitch cycles seriously affect the climate. A discussion points to the prime role that the sun should have on the earth's climate with respect to solar cycles' activity, irradiance, cosmic rays, cloud formation.

The safe conclusions drawn here are: (i) a natural signal of solar forcing has been mistakenly overlooked for an anthropogenic change, maybe due to their similar effects, (ii) for the moment science does not really have a complete understanding of the factors affecting the earth's complex climate system.

Thermal properties of rocks and compilation of geothermal maps of Cyprus

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Keywords: Hydroelectricity, Geothermal & Solar Energy

Previous studies classified the island of Cyprus in the category of low enthalpy with high potentials in the usage of geothermal energy for space air-conditioning. Given this knowing the underground thermal properties throughout the island is of great importance in the design of geothermal systems.

In this study an extended geological sampling is carried out on the island and lab measurements at room temperature of the thermal properties are performed for all the collected samples both in their dry and water-saturated state. The impact of water in samples, the mineralogical composition, and the geological age of samples are thoroughly studied. Laboratory results of each rock type in Cyprus are thus found within certain ranges for each thermophysical property, namely thermal conductivity, thermal diffusivity and specific heat capacity. Measurements show that thermal conductivity and thermal diffusivity under moisture conditions increase for most, but not all, of the lythotypes. Different areas of the island exhibit a significant difference in measured thermal properties. Moreover, the geological age of a lithology is shown to affect its thermal response. For instance, the thermal conductivity of reef limestone and calcarenite rocks increases with the geological age of the lithology.

Finally and most importantly, in order to understand and visualize all measured data, the geothermal maps of Cyprus with respect to thermal conductivity and thermal diffusivity are drawn through the use of a Geographic Information System (GIS) and ArcGIS software. This will constitute a powerful tool for engineers in the design of thermal engineering systems.

Forecast of recoverable Thermal Energy during the Extrusion of Thermoplastic Pipes

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Keywords: Energy Efficiency

Extrusion is an important method of polymer processing to produce e.g. tubes, technical profiles, films, cable coatings. A big share of thermoplastic material is used in pipes for water and gas supply or wastewater collection. Rising energy prices increase the pressure for extruder manufacturers and operators to energy costs. While extruding thermoplastic material, the material is heated and molten first by electric energy, which is used by screw drive and barrel heaters, then cooled to ambient temperature again using energy. One possibility cut energy cost goal is to collect and reuse the thermal energy which is contained in the melt for other purposes.

However, the reuse of the thermal energy must be planned and calculated before spending money at devices which do this. So the within the research program "Green Factory Bavaria" investigations and trials were done to find out, which amount of thermal energy can be collected in production lines for tubes. Along with these practical investigations a theoretical approach was followed to calculate energy transmission in the cooling system of the production line. The aim of this was, to develop a software tool for a manufacturer or user of extrusion lines, which gives a sound forecast for the energy and temperatures, which occur in the cooling water or cooling air used to cool down the pipe and to stabilize the thermal condition of the extrusion machine. The results and the calculation methods were adjusted to the trails done at shop floor.

The energy monitoring included the energy consumption of the main consumers and the waste heat amount of cooling chambers and barrel cooling for three different single grooved barrel extruders. The energy monitoring results show that some of the temperatures of the cooling chambers are high enough for reutilization. The barrel cooling waste heat can be fully reused. The program calculates the cooling of the tubular profile with finite element difference wherein the heat transfer is calculated in the radial direction. The thermal state of the tubular profile can be simulated at every position within the extrusion line. Furthermore the thermal output into the coolant can be calculated. The calculated and collected data are satisfactory more often than not. Based on the energy monitoring results concepts for the usage of waste heat were elaborated. Thereupon measures for the usage of waste heat were implemented and validated.

Air Traffic Management Programming for Minimizing Energy Costs

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Keywords: Transportation and Energy Efficiency

Air traffic management (ATM) is defined as the dynamic and integrated management of air traffic and airspace, safely, economically and efficiently through the provision of facilities and seamless services in collaboration with all parties. However, as traffic grows steadily, airport and air traffic congestion become a mounting problem that leads to an inefficient air traffic management system with low safety and with economic and environmental impacts. Furthermore, the ecological impact is mainly linked to the excess consumption of fuel and the release of carbon dioxide in the atmosphere. Indeed, it is estimated that up to 8% of all aviation fuel is wasted due to inefficient routes.

Therefore, in order to be aligned with the need for efficient routes and less excessive energy consumption during air flight, we present a two – level hierarchical architecture based on the methodologies developed by Dell'Olmo and Lulli in 2002 and by Bertsimas, Lulli and Odoni in 2011. The novelty of this research is the enhancement to the above models the ability: (i) to segregate the airborne delay cost from the ground holding cost, (ii) to impose cancellation policies, (iii) to take into account the arrival and departure capacity of each airport, (iv) to take into account the capacity of each arc, (v) to ensure connectivity and (vi) to minimize the cost of flight due to airborne delays, ground holding delays, flight speed and cancellation.

The problem is divided into two sub – problems (upper and lower level) in order to decrease the computational efforts and the complexity of the air traffic flow management problem and to allow flexibility between the decision maker levels enforcing in the same time free flight scenario. The mathematical modeling and simulation case studies with different air traffic scenarios will be presented and analyzed.

Analytical Study on the SCOP Improvement of a Vapor Injection Heat Pump

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Keywords: Energy Efficiency

A heat pump has been widely used due to its high efficiency. However, the capacity and reliability of a vapor compression heat pump decrease under lower outdoor temperature conditions because of the increase in the discharge temperature and the decrease in the suction gas volume. Vapor injection technique has been applied to the heat pump for improving the capacity and reliability of the system in cold weather conditions. Refrigerant vapor is injected into the compression pocket after vaporizing the refrigerant at the condenser outlet using flash tank or heat exchanger. In this study, the performance of a vapor injection heat pump was analyzed and then compared with that of the non-injection heat pump. The seasonal coefficient of performance (SCOP) of the vapor injection heat pump was measured and analyzed under various operating conditions. In addition, the SCOP of the vapor injection heat pump was compared with that of the non-injection heat pump. The vapor injection heat pump showed 6-9% higher SCOP than the non-injection heat pump. In addition, the vapor injection heat pump becomes more effective for improving SCOP at low ambient temperature conditions.

Thermodynamic design data of a single effect LiBr-H2O absorption chiller provided with a membrane-based microchannel absorber for air conditioning applications

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Keywords: Energy Systems

Absorption chillers allow the use of low-grade heat (waste heat or excess heat from solar collectors) to produce a cooling effect, with no (or minimal) mechanical power consumption. In buildings, this could help to optimize the solar thermal energy in the summer period reducing the electricity consumption peak due to air-conditioning. Nevertheless, their use is limited, compared to mechanical refrigeration systems, as they are generally larger in size. This is a clear inconvenient for the generalization of the absorption technology use, limiting its benefits in the contribution to the reduction in CO2 emissions, particularly for the LiBr-H2O solution which can work with low heat temperature sources as provided by solar panels.

The absorber is one of the most performance limiting and volume demanding components of this technology. The main challenge in designing and operating these devices is to maximize the mass transfer rate by getting as much interfacial area as possible, minimizing the overall size. This can be achieved using membrane contactors in microchannel heat exchangers. In the present work, the simulation of a LiBr-H2O absorber using porous fibers for the heat and mass transfer between the solution and the vapor phase is considered. The simulated membrane absorber is integrated in a complete single effect lithium bromide–water absorption chiller which performance is evaluated. For the case considered in this study, the absorber is 10 cm^3 in volume and can work in a chiller producing 9W of cooling, fed with heat at 80ºC. The results show how this new kind of absorber could be of interest for small-scale applications in buildings and dwellings air-conditioning appliances and, coupled with the use of solar thermal systems, it can be a way to reduce the electricity consumption in these applications.

A computational analysis on the performance of a PEM fuel cell with short-side-chain membrane

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Keywords: Renewable Energy

Polymer electrolyte membrane (PEM) fuel cell system is one of promising candidates for power sources because of the advantages such as zero emission, high efficiency, and quick start-up. In a PEM fuel cell, short-side-chain (SSC) membrane has been widely studied because it has better proton conductivity and durability due to higher crystallinity and glass transition temperature. Most studies on the PEM fuel cell with the SSC membrane are conducted by experiments, but numerical analysis is extremely limited. For general performance evaluation and prediction, more specific numerical analysis is required. In this study, simulations on the SSC membrane PEM fuel cell were conducted by using a steady-state three-dimensional model. The electrochemical reaction analysis was conducted through single straight channel and the proton conductivity of the SSC membrane was expressed as a function of temperature and water uptake based on the existing measurements. To validate the SSC model, the simulation results were compared with the experimental data in the literature, showing ±3.5% deviation. As a result, the cell performance was improved with the increase in the operating temperature because of active electrochemical reaction. However, the performance steeply decreased at 90 ℃ under high current densities due to concentration polarization loses. Additionally, the performance was improved with the increase in relative humidity. In order to prevent significant performance degradation, the relative humidity needs to be maintained over 50%.

A short-term rental E-Bike system for city/island transportation

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Keywords: Transportation and Energy Efficiency

This work intents to describe a new approach and service created in Greece that would be able to combine the positive effects from the use of an E-Bike short-term rental system in any size city/island (i.e. Santorini, Greece) while intending to serve as part of a movement to develop a local sustainable transportation as well as touristic system. The presented e-Bike-Inn is an automated online service for short-term rental of electric bikes (e-bikes) aiming at serving the transport needs of tourists, in particular those staying at a hotel in Greece. It provides a faster, more accessible and economical way of transport for the tourists in their everyday movements along with an ecological feeling in their holidays. The basic concept is a combination of the use of the E-Bike short-term rental system provided by the local hotels-motels, etc. with a charging design infrastructure and the use of Information and Communication Technologies while the user on routing.

Environmentally Constrained Economic Dispatch Problem — A Unified Model

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Keywords: Mathematical Programming and Energy, Sustainability & Climate Change

This paper presents a new model to address the existing shortcoming in determining the simultaneous solution of two conflicting objectives, cost, and emission. In economic and emission dispatch, the electric power producers are willing to minimize the generation cost; while on the other hand, the primary concern of committee of climate change (CCC) is to reduce the greenhouse gas emission (GHG). In order to satisfy both objectives mostly a multi-objective model is used. However, this paper aims at obtaining a solver-based model, and in this regard, first, the emission problem is linearized and then based on the strong duality theorem the multi-objective model is transformed into a unified model that is solvable by commercial solvers. The carbon tax, in the cost problem, is defined based on the locational marginal emission (LME). To verify the model, a commonly used case such as 30-bus IEEE system within multi-horizon scheduling time is conducted. Results show that via the proposed model the concerns related to the generation cost and emission can be addressed simultaneously while the adaptive LME-based tax may positively affect the emission reduction. Moreover, it can be deduced that this approach is fast enough to be applied to real-time problems.

Assessing uncertainties for climate change mitigation and adaptation pathways

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Keywords: Vulnerability, Sustainability & Stochasticity

During models' development both for future climate state assessment, as well as for the estimation of costs and benefits associated with different mitigation pathways, it is necessary to take into consideration a high degree of uncertainty. This issue encompasses the understanding of risks, uncertainties and co-effects related to different mitigation pathways as well as public acceptance (or lack of) of low-carbon (technology) options. The objective of work is to explore comprehensively which risks and uncertainties are associated with different climate policy choices, the qualitative and quantitative approaches used for their analysis, and potential bias in scientific research. Within it was developed a broad conceptual framework accounting for exogenous risks, as risks to the implementation of a policy choice, and consequential risks, as risks resulting from an implemented policy, in the areas of political, regulatory, social, economic and environmental risks. Moreover, uncertainties resulting from insufficient knowledge (epistemic), from lack of agreement on the framing of a problem (paradigmatic), or from conflicting scientific findings (translational) were also taken into account. The search covers climate policy choices in several sectors such as energy production, transport, agriculture and other land uses, buildings and other industry. Strong inclination towards energy producing sectors is visible from the beginning of the study. In addition, wide representation of quantitative and model-based analysis reveals the focus of the existing literature on epistemic risks, and in particular on economic risks, as many social, political and regulatory risks, are more difficult to assess quantitatively.

The work was performed within TRANS risk project that aims at creation of a novel assessment framework for analyzing costs and benefits of transition pathways that will integrate well-established approaches to modelling the costs of resilient, low-carbon pathways with a wider interdisciplinary approach including risk assessments.

Efficient utilization of biogas in Solid Oxide Fuel Cells

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Keywords: Bioenergy

Biogas is a valuable resource, which can provide the capability to compensate fluctuating electricity production from wind and photovoltaics. However, in order to achieve the best possible utilization of biogas it has to be used at highest efficiency. Solid Oxide Fuel Cells (SOFC) are the energy conversion device which currently offer the highest efficiency potential. In the presented study the effect of operating parameters on efficiency, contamination effects like carbon deposition, and system complexity are investigated using simulations in Aspen Plus. It is found that the share of carbon dioxide in the biogas plays a vital role with regards to all three aspects. As is shown especially carbon deposition is largely affected by the share of carbon dioxide, which in turn affects the amount of steam which has to be added to the biogas. Finally the system efficiency can reach 40-62%(LHV).

Demonstration of the Feasibility of the Misselhorn Cycle - Simulations on Thermal Inertia and Residence Time

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Keywords: Energy Systems, Batch Evaporation

In times of increasing use of renewable energy sources and the rising awareness of environmentally aspects, the energy field has to deal with various new challenges. The importance and severity of research on conventional energy sources is decreasing and the interest in innovative and new processes is high. The general goal is to improve the utilization of available resources and discover new prospects. The Organic Rankine Cycle (ORC) is an established process to efficiently recover low temperature waste heat. However, the thermodynamic limitations restrict its potential. The recently introduced Misselhorn Cycle aims for the same applications but its characteristic batch evaporation can avoid the pinch point limitations known from the ORC. This allows to outperform currently known system efficiencies by about 40%. The simulations in this work now show that the changing temperature and pressure levels as well as the thermal inertia of the process can be handled by a simple and viable process implementation. The improved performance of this cycle helps to save both resources and costs in waste heat recovery applications.

Emission of CO2 in Construction Materials: Ceramic Bricks and Soil and Cement Bricks, What is the Highest Emission?

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Keywords: emissions greenhouse gases, calculation of greenhouse gases, carbon dioxide from building materials

With the exponential growth of urban areas, the rational use of energy and inputs associated with reduced emissions of greenhouse gases from building materials shall be relevant role in the search for sustainable development. As the "" Emissions Scenarios "" (IPCC 2000), carbon dioxide (CO2) is the gas with higher anthropogenic inputs forcing the atmosphere. In Brazil the main sources are the combustion of fossil fuels and changes in soil, followed to a lesser extent by industrial activities, particularly the production of cement, steel, aluminum, and activities with intense energy consumption.

This work raises data on energy consumption and emissions in the production of construction materials on a case study detailing the methodology of calculation for emissions. The ceramic bricks can effectively emit 50 % less CO2 than bricks in soil and cement, known as ecological brick, however buildings in soil cement emits about three times less than buildings with ceramic used in most Brazilian constructions. We also conclude that shade walls reducing cooling requirements, prevent emissions during the entire useful life of the building independent of the type of masonry.

Study of the potential of fuel tax reforms to curb carbon emissions from road transport using the Value-Based Data Envelopment Analysis method

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Keywords: Operational Research and Energy, Sustainability & Climate Change

Road transport was responsible for around 20% of total GHG emissions in the EU-28 in 2013. The transport sector is the only major sector that has exhibited an increase in GHG emissions since 1990 making it the second largest GHG emitter in the EU after the energy generation sector. Preventing climate change is a strategic priority for the EU and policies to reduce energy consumption in the personal transport sector are an essential part of energy policies. Given its share in total GHG emissions, the transport sector will play a critical role in the mitigation efforts required by the Paris Agreement on Climate Change signed in December 2015.

Fuel taxation can be used to internalise a wide range of externalities, including those directly linked to fuel use, such as GHG emissions (especially CO2) and local air pollution (e.g. nitrogen oxide, particulate matter, and sulphur dioxide). Road transport policies have relied on fuel efficiency standards, which led to the political support for the dieselization of the car fleet in Europe. A major outcome of this political option was the prevailing preferential tax treatment for diesel fuel, leading to travel rebound effects that offset some of the CO2 and other benefits of its higher fuel efficiency.

This work is aimed at assessing the potential of fuel tax reforms to curb carbon emissions from road transport in some EU countries, using the Value-Based Data Envelopment Analysis (DEA) method exploring the links between DEA and multi-criteria decision analysis. The study considers fuel pricing policy scenarios, which are inspired by the current political agenda, to reduce GHG emissions in twelve EU countries. The adjustment of diesel excise tax levels towards gasoline taxation levels as well as the potential effects of introducing a carbon content-based tax of 50€ per ton of CO2 on both diesel and gasoline are studied. The performance evaluation by means of the Value-Based DEA method enables to identify the countries that exhibit the best practices defining an efficiency frontier. The gaps to best practices of non-frontier countries are measured and benchmarks against which those inefficient countries should be compared with are identified. This approach offers decision makers the possibility to incorporate their priorities in appraising fuel tax policies.

Synthesizing typical and extreme weather files for the impact assessment of climate change on buildings

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Keywords: Decision Support Systems

There exist several sources and scenarios for future climate, each having their own advantages and disadvantages. Considering climate change and assessing its impacts on buildings is challenging due to dealing with large data sets and considerable uncertainties. This makes the decision making process difficult, especially for designers and engineers. This paper suggests an approach for the impact assessment of climate change which is based on synthesizing weather data sets out of several climate scenarios, in a way to diminish the importance of climate uncertainties in the analysis. The approach is based on creating one-year weather data, representing typical, extreme-warm and -cold weather conditions for 30-year periods. This results in decreasing the number of simulations enormously by considering shorter periods and less weather scenarios. The usefulness and accuracy of the results are discussed for energy and moisture simulations in buildings.

The opportunity of MFF & Horizon2020
How to seize it & Lessons 2015-2017

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Keywords: Energy Systems

Since the national funding is constantly minimizing, the need for European funding is nowadays more than mandatory. In this work the importance of European funding, the different funding schemes and the basic conditions for applying will be mentioned. Furthermore, the different funding schemes concerning energy, environment and transportation will be highlighted. Last, the art of proposal writing will be introduced where an initial approach to the standard proposal structure will be made.

Machine learning & application to energy projects

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Keywords: Energy Systems

Today the rapid rise in the number of sensors in the fab has resulted to massive amount of raw energy-related data that has to be processed, aggregated, categorized and evaluated. Data by itself isn't useful. The energy industry is facing the challenge of converting huge torrent of data into actionable information to drive improvements in the energy production, distribution and consumption. To support these new data requirements, an entire ecosystem of computationally intelligent algorithms is emerging, including machine learning and advanced data analytics. These techniques can handle hundreds to thousands of variables in big or small datasets and unveil the hidden laws of practical energy management boosting prior techniques to overcome a number of well-known challenges of the energy sector.

Innovative Technology for District Heating and Cooling (InDeal Project H2020)

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Keywords: Energy Systems

Challenged by climate change, and coupled with the need to secure sustainable economic growth and social cohesion, Europe must achieve a genuine energy revolution to reverse present-day unsustainable trends and live up to the ambitious policy expectations. A rational, consistent and far-sighted approach to heating and cooling is key for ensuring such transformation. Toward this direction, district heating and cooling systems need to be more efficient, intelligent and cheaper. InDeal project, funded under H2020, will offer an innovative platform that will impose a fairly distribution of heating and cooling among the network's buildings by:

-Real–time energy consumption data gathering via artificial intelligent meters

-Identifying and evaluating the network's buildings' need and demand for heating and cooling depending to their energy efficiency, energy consumption and type of building (EDP tool)

-Predicting the short-term and long-term weather conditions and forthcoming need for heating and cooling (EDP tool)

-Monitoring and control the level of energy stored in network's storage stations and substations (SMT)

-24/7 monitoring of the DHC system by a central control platform and

-Minimizing heat losses via novel pipe design solutions and innovative insulation materials.

The target of InDeal is to turn the current DHCS into a new next-level automated DHCS that will guarantee the increase of the overall energy efficiency of the system accomplishing a fairly distribution of heating and cooling energy demands. In light of this, InDeal will make a significant step forward contributing to wider use of intelligent district heating and cooling systems and integration of renewables, waste and storage. The InDeal project is expected to contribute to the key objectives of the European energy research policy by promoting sustainable development, ensuring security and diversity of energy supply, improving energy efficiency and increasing industrial competitiveness. Alignment with European Commission target for reduction of greenhouse gases.

Assessment of a Hybrid Renewable Energy System (HRES) in a small island in Greece

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Keywords: Renewable Energy

The proper water and electricity management - in terms of demand and supply - is a key issue, especially in small islands, where the sustainability is connected to the availability of natural resources. In this research work, the development of a Hybrid Renewable Energy System (HRES) in Donousa, a small island in Cyclades complex in Aegean Sea, is investigated. The proposed system includes a wind turbine, a desalination plant, a small hydroelectric station, a pumping station and two water reservoirs and is designed with the purpose of producing hydropower and covering water demand. For the model simulation, daily meteorological data from the nearby station, as well as, the available historical data of water and electricity consumption were used. Concerning the electricity production provided by the wind turbine, it is assumed that 30% is incorporated directly to the power grid, while the remaining 70% of the generated wind power is available for the water pumping and desalination. Furthermore, in order to evaluate the performance of the system, three scenarios were conducted, based on different combinations of energy and water supply. Results of the simulation model concerning the system functionality are presented for a typical annual period on a daily and on a monthly basis. It was found that, in some cases, this investment may be considered as profitable for the local society and thus further investigation of such systems is needed. Also, since HRESs have not yet been widely applied especially in Greek Islands, the proposed approach could provide valuable information for both storage and controlled distribution of the generated net energy.

Cost-Based Recovery Mechanisms in a Duopoly with Non-Convex Costs

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Keywords: Competition in Electricity Markets

In day-ahead electricity markets, the generation units incur commitment costs (e.g., start-up or no-load costs), besides their marginal costs for generating electricity. These costs, which we refer to as fixed costs, make the total costs non-convex. Such market designs, when operated under marginal pricing, may produce outcomes where truthful bidding results in losses for the respective participants. Several different pricing schemes have been proposed to address this issue, but in order to fully evaluate each scheme, it is necessary to explore its implications on the incentives and the likely bidding behavior of the participants.

This work contributes to furthering our understanding on the bidding behavior of participants in markets with non-convex costs by employing exact analysis to identify equilibrium outcomes in a duopoly model representing electricity auctions under cost-based recovery mechanisms.

At first, one could argue that since the non-convexity arises from the fixed costs, this problem could be eliminated by fully compensating the participants for their fixed costs, whenever such costs occur, thus allowing them to compete with their bids reflecting their marginal cost. This is a simple fixed cost recovery (FCR) mechanism.

An alternative option is to compensate the participants with what we call a ``loss-related profits'' recovery (LPR) mechanism, which allows for a positive profit that is proportional to the losses. The idea is that a participant that exhibits losses has an incentive to maximize these losses, and hence has an incentive for low prices (the lower the price the lower the market revenues and hence the higher the losses). We show that the paradoxical behavior of the LPR mechanism, i.e., having increasing profits with decreasing prices, has some interesting properties and can be designed to outperform the FCR mechanism in terms of equilibrium prices and total payments.

Combine state-of-the-art machine learning models to forecast hourly solar irradiance in tropical regions

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Keywords: Renewable Energy

Located on the Equator, Singapore has one of the most challenging climate for solar irradiance forecasting. The tropical rainforest climate in the area demonstrates high variability in solar irradiance due to the dynamic and unpredictable cloud formation.

To provide a solid solution for hourly solar irradiance forecasting in the area, we design and implement three state-of-the-art machine learning models: extreme gradient boosting, random forests and adaptive boosting in hourly solar irradiance forecasting for tropical regions. These models have been applied to various machine learning competitions and proved to be the top performers. By using an averaging combiner, these individual machine learning models can be combined to improve the forecasting accuracy further.

To appropriately design and implement these models in hourly solar irradiance forecasting, input features are carefully prepared and processed. After proper feature selection, the machine learning models are implemented and optimized specifically for our application. Then the three models are combined together to achieve the optimal forecasting accuracy. The final combined model includes 3 random forests models, 2 adaptive boosting models and 1 extreme gradient boosting model, with different parameters to avoid overfitting.

After 5-fold cross-validation using the training data from 2014-2015, not only the combined model but also the individual models including the benchmark persistence model are tested on the 2016 data. The combined model has the best performance among all the implemented models.

Impact of Design approach of cold-climate greenhouse on Energy performance and GHG emissions

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Keywords: Energy & Environment

This work presents a comparison between the energy performance of two approaches in the design of a greenhouse for agriculture production in cold climate, and their associated GHG emissions. The first approach considers a design that allows controlled indoor agriculture. The building therefore relies on artificial lighting, and is associated with reduced amount of glazing. The second approach adopts a more conventional, glass dominated, greenhouse design. Our work summarizes the results of an extensive optimizing of the building envelope of these two prototypes, and compares their energy performance and corresponding GHG emissions. Edmonton, Alberta, Canada (54°N) is assumed as the pilot location for the study, representing a northern cold climate zone. Heating, cooling and lighting loads, together with photovoltaic electricity generation, are the parameters defining the optimal design.

The study indicates that, for the minimally glazed greenhouse, the optimization of building envelope components such as insulation, window assemblies and phase change materials, allows reduction of thermal load by 60%, relative to the base case design. The base case design is built according to existing norms and standards. Employing building integrated PV (BIPV) system, this optimized model reaches an energy positive status. In the glasshouse, replacing window assemblies by semi-transparent PV systems, with low-e glazing and argon fill cavity, together with the implementation of moveable insulation and shading screen with 25% solar transmittance (activated during peak solar radiation hours), enable positive energy status. Energy consumption of the optimized glass dominated greenhouse is however 35% higher than the optimal minimally glazed greenhouse. The enhanced energy consumption of both buildings allow a significant reduction of the associated GHG emission. This is especially due to the fact that the electric grid in the studied location relies heavily on fossil fuel.

Eco-driving by replicating best driving practices

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Keywords: Transportation and Energy Efficiency

Vehicular fuel consumption represents about 50% of the operational costs of transit companies and ~24% of the world energy-related CO2 emissions. Best drivers, after years of experience using the same vehicle technology have learned the proper combination of vehicle speed and engine RPM to operate the engine in points close to the green area at each section of the road. On that decision process they take into consideration previous engine operating conditions and external factors such as on-road traffic and safety. Therefore, significant additional SFC savings can be obtained by guiding drivers on the best instantaneous operational parameters of speed and RPM to drive the vehicle. We propose to further reduce fuel composition by reproducing best driving practices, which consist on guiding drivers on the recommended ranges of vehicle speed and engine RPM that lead to minimum fuel consumption.

We demonstrated this approach by monitoring a fleet of 15 transit buses of recent technology during eight months of normal operation, serving a route of general characteristics, i.e., located at high altitude (>1000 meters above sea level), which topography included significant altitude changes (>500m), with urban and suburban traffic. We identified the best driving practices per 1 km of road partitions. Using their eco-driving training they obtained a 7% reduction in fuel consumption with respect to the average of the population, and by reproducing the best driving practices, their savings increased up to 10%. Those drivers increased the average energy efficiency use of the engine from 24.9% to 25.5%.

Environmental Considerations in Supply Chain Management

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Keywords: Sustainability in Supply Chain

The literature on supply chain coordination is vast; however, the interrelationship between coordination and environmental sustainability is yet to be further investigated. In this work we consider a decentralized two-node supply chain with a retailer and a supplier to quantify the impact of coordination on the environment in terms of fuel consumption and emissions. Environmental consideration in supply chain management becomes more and more important for many firms as it is imposed mainly by new legislation as well as the need to improve their environmental profile as demanded by their customers. We assume that the retailer works under the Economic Order Quantity model while the supplier works under the lot-for-lot policy because he cannot accommodate inventory. The supplier is allowed to use a quantity discount to manipulate the retailer's decision and reduce the operational costs by decreasing the frequency of deliveries. This results in a reduction of fuel consumption and emissions. We establish the magnitude of this reduction using numerical examples under specific operational parameters of both nodes. We investigate both complete and incomplete information cases, where the nodes make their decisions independently to optimize their own objective functions.

Integrated system of vapor compression and thermosiphon based on three-fluid heat exchanger: A reliable and effective way for cooling energy-saving of data centers

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Keywords: Energy Efficiency

With the growth of the scale and number of data centers around the world, its cooling energy consumption increases rapidly. It is an urgent need to reduce this consumption. Free cooling, which means utilizing natural cold source to cool a data center, is an alternative way. Integrated system of vapor compression and thermosiphon is one kind of cooling system which works in free cooling mode in cold season and works in vapor compression mode in hot season. Therefore, it can achieve free cooling meanwhile do not need auxiliary mechanical refrigeration equipment. In this paper, three different types of integrated systems are compared and the advantages of integrated system based on three-fluid heat exchanger are analyzed. The performance of a prototype of this system is investigated experimentally and it is shown that it has efficient cooling capacity and high energy efficiency ratio. The free cooling potential in different cities across China is calculated. It is shown that in most regions of China, integrated system of vapor compression and thermosiphon based on three-fluid heat exchanger has great potential for energy-saving of data center cooling.

Experimental Assessment of a Solar Cooling System for Ice Production

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Keywords: Renewable Energy

A solar powered intermittent absorption refrigeration system has been developed and evaluated with the ammonia/lithium nitrate mixture. The system is a new version of a previous prototype designed where a cylindrical direct evaporator was used instead of an indirect serpentine evaporator.

The system, designed to produce up to 8 kg/day of ice, was developed at the Instituto de Energías Renovables of the Universidad Nacional Autónoma de México. It consists of a Compound Parabolic Concentrator (CPC) with a cylindrical receiver acting as the generator/absorber, a condenser, a storage tank, a direct evaporator with eighteen water containers for the ice production and a capillary tube. Due to lithium nitrate does not evaporate at the operating conditions, a rectifier is not necessary in the system.

The system operates solely with solar energy and no moving parts are required. The developed prototype operates intermittently, which means that the generation and refrigerant condensation happen and the same time, while the evaporation and absorption process take place in a second step.

Several test runs have been carried out at different solution concentrations of the mixture. The system achieved temperatures in the CPC in a range between 100 °C and 120 °C. Evaporator temperatures as low as -8 °C were obtained for a time period of 8 h, producing the ice bars. The solar coefficients of performance for the system have been close to 0.1.

The solar refrigeration system has proved to be a good technological alternative for ice production where electricity supply is not available.

Energy Target of a Fluid Machinery Network in a Circulating Water System

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Keywords: Process Optimization, Synthesis, Design and Operation

A circulating water system is widely used as a cooling system in process industries, so its energy consumption has a great impact on the energy performance of the whole system. In a circulating water system, the pump network composed of main and auxiliary pumps offers power to the system, while the water turbine network recovers excess energy. A fluid machinery network in the circulating water system is then formed with the interrelation among pumps and water turbines. The difference value between the minimum theoretical power requirement of the pumps network and the maximum theoretical power recovery by the water turbines network is the energy target of the fluid machinery network. It is very significant for guiding the energy conservation of a cooling system, as energy target means the theoretical limit of the network's energy consumption. In this work, by the analysis of influence factors on energy target in a fluid machinery network, the concept of effective heights of a branch and cooling tower are introduced to obtain the necessary condition of a water turbine placement. Then a mathematic model to determine the energy target in a fluid machinery network is proposed. A case study is used to validate the applicability of the model finally.

Impacts of Ca/Na compounds on coal gasification reactivity and char characteristics in H2O/CO2 mixtures

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Key words: Coal gasification; Ca/Na compounds; Catalytic effect; Composition effect; H2O/CO2 mixtures

The effects of Ca/Na compounds on the gasification performance and char characteristics in H2O and CO2 mixtures were investigated in this study. The gasification reactivity of Ca-loaded coal (Ca-WCWD), Na-loaded coal (Na-WCWD), and Ca/Na-loaded coal (Ca/Na-WCWD) were tested and compared by TGA in different gasifying agents including 100% H2O, 100% CO2, and 66.7% H2O+33.3 %CO2. Partially-gasified chars of Ca-Na-WCWD with carbon conversion of 50% were prepared in different gasifying agents and characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD) and nitrogen adsorption measurement. The results indicate that Ca together with Na show a composition effect towards the gasification reactivity which is the most obvious in H2O/CO2 mixtures, and Na can promote the synergistic effect caused by Ca catalysis at higher temperature (900 °C). Na existed in Ca/Na-loaded coal can inhibit the agglomeration of CaO due to its excellent mobility and the formation of eutectic Na2Ca(CO3)2. It is the most obvious improvement of CaO dispersion on the particle surface of the partially-gasified char in H2O/CO2 mixtures that results in the remarkable composition effect between Ca and Na and causes the obvious synergistic effect at higher temperature. Moreover, the composition effect between Ca and Na during catalytic gasification can not only facilitate the gasification reactivity but also promote the development of pore structures of the gasified char, especially in H2O/CO2 mixtures.

Effects of low molecular compounds on catalytic reforming of gaseous tar during coal pyrolysis

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Keywords: Fuels

Catalytic reforming of gaseous tar from coal pyrolysis is a reasonable way to convert heavy tar into light arenas, and this method can achieve high value-added utilization of heavy tar. Coal is composed mainly of organic macromolecular skeleton in dispersed form mixed up with a variety of free low molecular weight compounds. Low molecular compounds in coal can have an effect on the catalytic upgrading of gaseous tar. Therefore, low molecular weight compounds were extracted from mineral-free lignite coal (Coal DA) and bituminous coal (Coal DB) using pyridine as the solvent, and the gaseous tar from the pyrolysis of raw coal and their residual coal (Coal DAR and Coal DBR) was catalytic upgraded using USY zeolite. The pyrolysis products were analyzed by gas chromatography-mass spectrometry (GC/MS). Then, the effects of low molecular weight compounds in coal on the production of benzene, toluene, xylene and naphthalene (BTXN) in this process were investigated. The results show that the BTXN yield in Coal DAR and Coal DBR is 42% and 10% lower than that in Coal DA and Coal DB, respectively, indicating that the extraction of low molecular weight compounds results in a significant decrease in the BTXN yield. Low molecular weight compounds could provide low molecular weight free radicals for catalytic reforming of coal tar, thus contributing to the stabilization of fragments and subsequently the formation of light aromatics. Extracts accounts for 23.7% of Coal DA and 7.2% of Coal DB, respectively. The low molecular weight compounds in Coal DA are predominantly aliphatic compounds (72.7%) and O-containing aromatics (21.9%), whereas that in Coal DB is predominantly naphthalene series (33.1%) and condensed aromatics (29.4%). Thus, low molecular weight compounds have a more pronounced effect on the catalytic reforming of tar from pyrolysis of low-rank coal.

Effects of gasification atmosphere and temperature on char surface morphology and pore structure evolution during the gasification

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Keywords: Fuels

The purpose of this work is to study the effects of atmosphere and temperature on the surface morphology and pore structure characteristics of char during the coal char gasification with CO2, H2O and their mixture. The gasified char with carbon conversion of 0%, 30%, 50% and 70% was obtained by the low rank bituminous coal gasified under 40%CO2, 40%H2O, 20%CO2+20%H2O at 800oC, 900oC and 1000oC in a fixed bed gasifier. The chars were characterized by scanning electron microscope (SEM) and nitrogen adsorption method. The results show that the atmosphere and temperature have significant effect on the surface morphology and pore structure in the gasification process. CO2 char has an uneven surface with irregular potholes, while, the surface of H2O char is relatively smooth and there are neat pores distribution on its surface. The char structure develops loose and the surface becomes rough at high carbon conversion. The pores of CO2 char are mainly micropores and a small number of little mesopores, the pores of H2O and H2O/CO2 char have not only micropores, but also abundant mesopores and even some macrospores.

LV versus MV Chillers: Comparative Analysis of the Electrical Requirements and Environmental Impacts

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Keywords: Energy Systems

Electric Chillers for buildings demand for a variety of resources through its lifetime. During initial construction phase, chillers require electrical supply backbone, distribution equipment such as switchgear, and floor and shaft area for installing different balance of system components, such as transformers and cables. During operational phase, they consume electric energy, and require routine maintenance. The Chiller compressor is the primary component, dictating all requirements. The compressor motor voltage is recognized as the most important factor.

A comparative analysis between the electrical requirements, criteria and performance of Low Voltage (LV) and Medium Voltage (MV) chillers motors was carried out. Three chillers (1000TR each), were taken as case study; one Low Voltage compressor motor (415V) with standard efficiency and two Medium Voltage compressor motor (11kV) with standard and high efficiency.

Load analysis, cable sizing and equipment sizing calculations were performed for the chillers separately. Each of the chillers motors technical, financial, operational and environmental performances was analyzed for lifetime. Impacts of the chillers operations on the power quality were also studied. Based on the analysis; both standard and high efficiency MV chillers outperform the LV chillers in the considered aspects. For MV chillers, both standard and high efficiency chillers have comparable performances with the High efficiency one being slightly better.

Structural evolution of a bituminous coal char relating to its synchronized gasification behavior with H2O and/or CO2

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Keywords: Fuels

This work aims to investigate the structural evolution of the char during gasification under a single or mixed atmosphere of H2O and/or CO2 with the synchronized investigation of the effect of the varying char structure on the gasification reactivity. The experimental char was prepared from a bituminous coal at 1000 oC. The changes of the char structure along with the progress of the carbon conversion during gasification were characterized using N2 adsorption and Raman spectroscopy. In terms of a single gaseous atmosphere, it was found that H2O showed a much higher reactivity with the char than CO2, which resulted in a more dramatically change on the char structure. The specific reaction rate between the char and CO2 decreased monotonously with the increasing carbon conversion. However, the opposite trends were observed when H2O existed, either H2O alone or the mixtures of H2O and CO2. These different observations might be attributed to the selective depletions of the carbon that is able to react with the introduced gas of CO2 or H2O on the char. This behavior thus could affect the evolution manners of the char structure. The quantities of H2 and CO based on the experimental results were lower than the calculated values for the gasification with CO2. In terms of the mixed atmosphere, the reaction between C and CO2 (C + CO2 → CO) was most likely to be promoted due to the special structure under cooperative efforts of H2O and CO2. This is the explanation that the specific reaction rate in the mixture of CO2 and H2O between the introduced gas and the char is higher than the expected value. Meanwhile, water-gas shift reaction (CO + H2O → CO2 + H2 WGS) was suppressed in the coexistence of H2O and CO2. Combining the structural evolution, specific reaction rate and the concentrate of released gases, a modified oxygen transfer mechanism was used for understanding the char gasification in coexistence of H2O and CO2.

Effects of mineral matters on the interactions between lignite and corncob during temperature-programmed co-pyrolysis

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Keywords: Fuels

A lignite and a corncob were employed to investigate the effects of the inherent minerals on the interactions between lignite and corncob during pyrolysis. Prior to pyrolysis experiments, the selected samples were demineralized by using HCl and HF solution. Pyrolysis experiments for the raw samples, demineralized samples and their various purposeful blends of lignite and corncob were conducted in a lab scale fixed-bed reactor. The results showed that the inherent minerals can significantly affect the pyrolysis behavior of the individual feedstocks. Particularly, it was observed that the alkali and alkaline earth metal species (AAEMs) in corncob (CR) was capable of promoting the decomposition of tar macromolecules and cracking liquid tar to form gas and char, which thus led to an increased gas yields with distinct soot observed. In terms of the blends, it was observed that the blends which were composed of the demineralized corncob and the demineralized lignite produced an unexpected higher yield of liquid tar than other blends. This suggested that the AAEMs in corncob or lignite could play a catalytic role in the decomposition of tar macromolecules and this catalytic ability in corncob became stronger than that in lignite. The experimental results also indicated that the catalytic ability of the AAEMs varied in the blends of lignite and corncob. For the blends of the raw samples of lignite and corncob, this catalytic ability of the AAEMs was weaker for decomposing tar macromolecules compared to that in the blends of raw corncob and demineralized lignite or demineralized corncob and raw lignite. The AAEMs also showed stronger catalytic ability in the blends of one raw sample and one demineralized sample, either lignite or corncob, than in the blends of the two raw samples. Therefore, the interaction between catalytically-active K and Ca species from corncob and the aluminosilicate species in the coal mineral matter occur, leading to the formation of calcium silicate(Ca2SiO4), which resulted in the formation of inactive compounds. In addition, it was observed that the inherent minerals in the raw samples could promote the reactivity of char with oxygen, which could be particularly observed with the char made from the raw sample of corncob.

Bottleneck Identification of Multiple impurities water networks

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Keywords: Process Optimization, Synthesis, Design and Operation

In this work, based on the mathematical model for water networks with multiple impurities in direct reuse mode, the bottleneck of the water network is investigated by sensitivity analysis. The bottleneck of the water network is defined as such water-using units whose tiny changes at limiting inlet or outlet concentrations will lead to the variation of the minimum flow rate of freshwater. The results in this work show the bottleneck of the water network is closely related to the units whose actual inlet and/or outlet concentrations reach their limiting values. By sensitivity analysis, the influences degree of the above-mentioned units' limiting inlet and/or outlet concentrations on the minimum flow rate of freshwater can be obtained, and the primary and secondary water-using units which affect the minimum fresh water consumption are distinguished. In this way, the bottlenecks of the water network can be determined.

Agricultural Burning Impact Area

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Keywords: Emissions

Agricultural burning is still a common industrial practice around the world. It is associated to high emission of air pollutants, including Black carbon and PM2.5. Environmental authorities require to identify its area of influence as legal requisite to start regulatory actions to control them. Nevertheless, the size of this area has not been quantify, mainly because the modelling of an open burnings represent a challenge for modelers: it is a short-term phenomenon of a moving diffusive area source.

We developed a methodology to assess the agricultural burning impact area using Gaussian models. It considers an area source located on flat terrain and burning under the worst-case air dispersion scenarios. Results are presented in terms of non-dimensional numbers for concentration and distance to the area source. The area of influence was determined as the longest distance where short term concentration (1 hr. - 1 day) exceed local air quality regulation of any of the pollutants regulated at least one time under worst but real meteorological conditions. We found that for the case of sugar cane burning in a tropical region this area has a radius of 3 km and that the most limiting pollutant is PM2.5. We also present alternatives for authorities to regulate this activity.

Optimum Rotor Design for a Wind Turbine

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Keywords: Renewable Energy

Harvesting energy from wind by using wind turbines have become popular in last decades. To capture the maximum energy available in the wind an optimum rotor design is needed. The rotor optimization is made by using one dimensional blade element momentum (BEM) theory and MATLAB software. After defining BEM in a 1-D control volume effect of rotation Prandtl and Glauert tip loss factors were explained. In the rotor NACA4412 profile was used. The obtained results by using BEM were compared with XFOIL software and it has seen that the BEM is valid. Optimum chord and tangential load distribution, coefficient of performance, optimum coefficient of performance, annual energy production and optimum twist angle of the blade were calculated.

Deep Removal of Thiophene from Coking Benzene

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Keywords: Energy & Environment

Benzene is an important chemical feedstocks, and coking benzene, the byproduct of the coking industry, is one of its main resources. However, the impurities especially the thiopehene present are difficult to remove because of the similar physical and chemical properties to those of benzene. Based on this, a green two-step process for the desulfurization of coking benzene was evaluated. The thiophene in coking benzene was first alkylated by the olefins present in it using a suitable AlCl3/silica gel catalyst to produce alkylthiophenes, which can be easily separated by distillation. The residual thiophene with its concentration range of 100–1000 mg/L in benzene was then almost completely removed by adsorption using CeY zeolite. The product met the requirements for a chemical feedstock, in that no thiophene was measured in the purified benzene by gas chromatography with a flame photometric detector. The CeY zeolite with adsorbed thiophene was used to prepare polythiophene–CeY composites by chemical oxidative polymerization.

Optimized Wastewater Network Topology of a Typical Resident with the Use of Metaheuristic Algorithms

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Keywords: Energy & Environment

Fresh water tends to increasingly comprise a scarcity today both in arid or even demographically boosted regions of the world such as big and smaller cities. On this basis, research is directed towards minimization of fresh water supply to a Water Network Topology (WNT) which might be comprised of a cluster of agents which have certain demands for fresh water dependent on their daily uses. This work is divided into two main parts. The microscopic level which simulates optimal waste water flows within a representative building unit, a household of 4 inhabitants which represents a large part of the total building stock in Luxembourg. This study therefore attempts to examine optimized fresh and waste water flow pathways involving pre-treatment as well as post-treatment water flows. At first, a single typical household of four (4) occupants is examined. This is achieved by adopting different algorithm methods such as the Sequential Quadratic Programming (SQP) and metaheuristic optimization methods such as Genetic Algorithms (GA's) through suitable computational platform tools such as MATLAB and GAMS. At first, a comparison study is realized on a single household unit with two different mathematical model formulation approach versions. The second part of this study comprises the simulation and development of the Water Network System (WNS) of a larger scale, i.e. in the neighbourhood level within the urban context, which encompasses, building stock, agricultural and infrastructure of the tertiary sector with different envelopes of uses. Integration to the WNS of existing Waste Water Treatment Plants (WWTP's) will enhance attempt to more closely reach the optimum.

Role of CO in Affecting CO2 Gasification Reactivity of Biomass Chars Generated from a High Pressure Laminar Flow Reactor

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Keywords: Fuels

Char-CO2 gasification kinetics are important to the design of highly efficient biomass gasifiers. In a commercial gasifier, char-CO2 gasification occurs in the presence of CO. Therefore, incorporating the role of CO is necessary for the development of a high fidelity kinetic model. In the present work, chars from ground coconut shell and switch grass were generated in a high pressure laminar flow reactor at a temperature of 1100 oC and a pressure of 11.3 Bar. The chars were characterized for pore structure, CO adsorption, and morphology, function groups (FTir), and char reactivity. Char-CO2 reactivity in the presence of CO was studied at different temperatures and CO2/CO concentrations using a High Pressure thermogravimetric analyzer. The kinetic parameters determined using Langmuir–Hinshelwood model are presented.

The causal relationship between pollution, energy consumption and output in Southeast Asia Countries

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Keywords: Carbon Emissions, Energy consumption, Economic output, Southeast Asia.

Southeast Asia is the region that has experienced rapid economic and population growth with high energy dependency and also significant rise in energy consumption and as a result has experienced a significant rise in pollution emissions in recent years. However, there are vast differences in the scale and patterns of energy use and energy source endowments within the countries in the region. Therefore, it is very interesting and important to understand the relationship between carbon emission, energy consumption and economic output and how these variables link to each other. Are the patterns similar or different among these countries? The main objective of the research is to investigate the causal relationship between these variables in the selected individual Southeast Asia Countries (SEA) using a causality model for the period 1971-2013. The results to some extent show evidence of the relationships between these variables, indicating that energy consumption and output are related to CO2 emissions. The results suggest that policies relating to a reduction of energy consumption, or an improvement in energy efficiency, or investigation of new energy sources, should be taken into consideration as they could reduce the level of CO2 emissions, under the umbrella of sustainability, without seriously affecting the Nation's economic growth.

Bayesian Network for Using e-Vehicles as Power Storage

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Keywords: Energy Systems, Power Storage, EVA

Micro grids are evolved to be the center of energy freedom for a region or zone using the distributed portfolio of renewable energy resources. However, the uncertainty of renewable energy sources enforces the use of power storage, whenever possible. This study targets Industrial Zones, where, there is heavy mobility of both logistics and employee transportation. The question is to see if all the trucks and buses were replaced by EVs, could the uncertainty be reduced by detail planned power storage using these vehicles. The trucks are mainly out of the zone daily or long duration, but parked in the zone. The service buses for the employees stay in park during the day as majority of the cars used. This study works on a cognitive map that designs the impact factors using e-vehicles as storage. Bayesian Belief Network uses the cognitive map to construct scenarios, which support the decision to use e-vehicles as power storage in an Industrial Zone. Probabilistic scenarios are modeled to consider Grid connection and fully autonomous cases, as well as partly e-vehicle usage cases, in order to respond to the industrial demand.

LIFE GreenYourMove Project

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Keywords: LIFE Environment & Resource Efficiency, Journey Planning

GreenYourMove main objective is the development and promotion of a co-modal journey application to minimize GHG emission in Europe. GreenYourMove develops a multi-modal transport planner (both routing & ticketing system) considering all kinds of urban public transportation (urban and sub-urban buses, metro, tram, trolley, trains), where the user gets alternative routes combining more than one transport modes if necessary. The routes are the environmentally friendliest ones, since emissions are calculated for different scenarios.

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Applying Benders Decomposition

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Keywords: Operational Research and Energy, Sustainability & Climate Change, Benders Decomposition, Crude Oil Scheduling

This study addresses the convergence rate of the Benders algorithm, when it is applied on a Mathematical Model. More specifically, it deals with the fluctuation of the Upper Bound (UB) of the algorithm, when the Model is a problem of minimization. The authors have noticed that, after a feasible solution of the Primal Subproblem is found, thus initializing the Upper Bound ($UB<+\infty$), then the value of the latter fluctuates in the following iterations. This fluctuation is considered to decrease the convergence rate of the algorithm. In order to deal with this fluctuation, the authors propose the addition of a cut in the Dual Subproblem in order to restrict its feasible space resulting in an Auxiliary Dual Subproblem. In each iteration, both the classical Dual Subproblem and the Auxiliary Dual Subproblem are solved and two Benders cuts are added to the Relaxed Master Problem. The proposed method has been applied on the Crude-Oil scheduling problem, which has been formulated as a Mixed Integer Linear Problem. The fluctuation of the Upper Bound and the convergence rate of the proposed method are compared with the classical Benders algorithm and the results are promising. However, more research is needed so as to better understand the deep causes of the aforementioned fluctuation and its relationship with the algorithm's convergence.