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Table of Contents

Environmental Policy Incentives Facing Private Information

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Keywords: Principal-Agent model, Conservation, Incentives, Observation-Equivalence

Environmental problems and their and mitigation by incentives, often encouraging conservation, are characterized by two distinct features: Benefit-cost trade-offs and private information about the trade-off. This suggests a degree a freedom where to attach the private information, either to the evaluation of the benefit or the damage cost, as long as the same behavior results absent incentives, `observation equivalence'. However, this paper shows that different but observation equivalent specifications can lead to different incentives. This is demonstrated exemplary for rainforest protection and contributions to a public good.

Bilateral Information Asymmetry in Inventory Management: Coordination via Mediation

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Keywords: Supply Chain Management, Quantity Discounts, Mediator, Mechanism Design, Communication

We study inventory coordination among production and warehousing facilities where manufacturing and storage costs are controlled by different companies or business units. The latter have discrete private information that affects their reservation levels and the way in which they decide on their actions. The nodes are allowed to communicate before they finalize their strategies via a credible mediator. The latter designs a mechanism to minimize the overall supply costs and lead to lower individual node costs. Using the Revelation Principle the mediator is able to capture private information of the nodes and it is proved that perfect coordination is attainable under two-way information asymmetry. Furthermore, there is considerable flexibility in determining the cost allocation between the nodes; this flexibility is quantified by a series of computational experiments

Urban water resource management in a nexus perspective

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Keywords: Urban, Water, Metabolism, Transformation, Ecosystem

In recent years, the sustainable utilization and integrated management of water resources have become an important part of urban planning. The resource metabolism network facilitates to identify the key nodes and metabolic pathways of water transformation, and quantify the water allocation mechanism in the socio-economic sectors to provide strong support for the efficient and resilient management of urban water resources. In order to improve the water resource utilization efficiency, technologies like geographical information and big data are required to optimize the urban water resource metabolism considering spatial heterogenicity and ecosystem function level. Due to the coupling effects of elements and pathways in water cycle, it is also necessary to update the current single-element mode to the multi-resource nexus mode, which enables the collaborative urban water resource management of a resilient city.

HEAT-R: Waste Heat Revalorization in Energy Intensive industries

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Keywords: Energy Harvesting, Waste Heat Recovery, Thermoelectricity, LIFE

Energy intensive industries (iron & steel, cement, glass, chemical & petrochemical, food, paper, wood, automobile, mining etc) lose up to the 70% of their energy consumption in form of waste heat emissions. This energy lost corresponds to 700TWh yearly due to the energy inefficiency. It corresponds to 21% of the energy needs of Europe per year.

Alternative Energy Innovations (AEInnova) is a Spinoff of the Microelectronic and electronic system department of the Autonomous University of Barcelona. Our efforts are focused in revalorizing industrial waste heat converting it into negative carbon electricity, improving significantly the efficiency in industrial processes reducing waste heat and GHG emissions.

In the 70s NASA incorporated in Voyager Spacecraft the first thermo-electrical generator. It has been working, free of maintenance, for over 40 years. AEInnova takes this technology validated in space applications and integrating our patent system-on-chip technology to harvest waste heat generating clean energy using high-end Japanese, American and European TEG Cells. The technology allows to recover easily up to 10% of the total industrial waste heat with a global market volume of 4,200M€. This solution has been validated successfully in the Volkswagen facilities of Barcelona, in 2016, in real environment conditions overcoming TRL6.

This paper analyses and identifies the most potential industrial sectors and countries in Europe in order to justify the installation of 6 different pilots in different target industries during the duration of the project (2018 – 2020). Moreover presents the general description of the whole harvesting platform.

This European R&D project is called HEAT-R, and it is funded by the European Commission LIFE Environmental Program and is the biggest project in thermoelectric applications for waste heat recovery in big energy intensive industries nowadays."

INDU-EYE Battery-less Wireless IOT Device for Industry 4.0

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Keywords: Energy Harvesting, Channel Hopping, Enterprise Ready Security, Battery-less IOT

Energy Intensive Industries have an opportunity to become more efficient, cost-effective and environmental friendly using battery-less IOT wireless sensing technology.
Focused in the oil & gas, petrochemical and chemical, with large facilities in ATEX explosive zones, they have limitations to achieve the Industry 4.0 goals. Basically due to infrastructure costs (using wired sensors) or maintenance costs (using wireless sensors with batteries that need to be replaced).
Alternative Energy Innovations is a Spinoff of the Microelectronic and electronic system department of the Autonomous University of Barcelona. Our efforts are focused in revalorizing industrial waste heat for powering edge computing wireless IOT devices.
AEinnova has created the first battery-less, free of maintenance, wireless and self-powered by heat IOT device in the market for energy intensive industries It fuses the state-of-the-art technologies thanks to the energy management through the reinforcement learning, channel hopping with noise reduction, multilevel power amplification, the model free optimization. Also incorporates enterprise ready security as AES-128 for an environmental resilient.
This paper analyses this technology opportunity and presents a proof of concept of it installed recently in a big oil refinery using the basis of this technology.
This research is aligned with the H2020 FET-PROACTIVE HARVESTORE project were AEInnova and the Microelectronic and electronic system department of the Autonomous University of Barcelona are the technology integrators of the biggest European Consortium for the Energy Harvesting and the IOT.

Tracing Electric Energy Spikes by Piecewise Monotonic Data Approximation

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Keywords: Spike Estimation, Extremely Large Data Sets, Least Squares Minimization, Piecewise Monotonicity Condition

It is commonplace that it is cheaper to save electricity than to produce it. But how can we make a dependable estimation of electricity savings? Relatively easy we can distinguish between normal -easy to forecast- prices and abnormal - spike like prices. The calculation of the spikes of demand and prices at peak periods yields the electric energy savings.
The next step is to handle properly extremely large data sets concerning electricity prices and quantities per hour, distinguishing inevitable spikes from spikes that can be reduced, because not all spikes are the same. Each spike can be created by a different cause, for instance, some spikes are high when the demand is high, others are high when generation reserve is smaller than a certain level. Easier to deal with are expected spikes at daily peak hours and spikes at working days in comparison with normal prices in weekends and public holidays. The estimation of spikes raises an important, yet a challenging combinatorial problem due to the large number of options of spike combinations.
Fortunately, the problem of spike estimation can be solved routinely as a least squares minimization of the energy prices subject to the condition that the prices have no more than a prescribed number of monotonic sections. This is a highly efficient calculation that allows us to incorporate a priori knowledge about the geometry fluctuation of the electricity prices. Thus the innovation of this work lies in the use of the piecewise monotonicity condition in the general problem of spike estimation in energy prices. We use 22,889 hourly observations of Greek Power Authority between 19 November 2001 and 11 July 2004 and, we present experimental results and discuss issues related to the new algorithm and the problem of calculating electricity savings.

Monitoring Network for PM2.5

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Keywords: Spike Monitoring, PM2.5, LIFE, GreenYourAir, GreenYourMove, GreenYourAir,Air Quality

GreenYourAir team has developed a monitoring network for PM2.5 using air quality measurements through the deployment of reliable low-cost sensors to complement the official air quality monitoring stations. The network was developed based on the outcomes of previous EU project like LIFE Vaquums Project, iSpace project and test implemented by the team. GreenYourAir project focuses on: 1) the monitor of the environmental impact (PM2,5 savings) of GreenYourMove and GreenYourRoute projects; 2) the correlation of medical incidents and levels of PM2.5; 3) the quantification of the origins of air pollution in Volos city; and 4) the suggestion to public authorities and private entities solutions to improve air quality in Volos city by decreasing the level of PM2.5. The project includes mainly six actions: Action 1: Design and deployment of air quality monitoring system; Action 2: Monitor air quality and its impact; Action 3: Statistical analysis of collected data; Action 4: Quantify the origins of air pollution in Volos city; Action 5: Suggest solutions; and Action 6: Implement solutions.

Inventory Routing Problem: A New Integrated Clustering and Routing Algorithm

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Keywords: Inventory Routing Problem, Tour-Generation Based Heuristic, Location Based Heuristic, Integrated Clustering, Capacitated Concentrator Location Problem

Inventory Routing Problem (IRP) arises from vendor-managed inventory business settings where the supplier is responsible for replenishing the inventories of its customers over a planning horizon. In IRP, the supplier makes the routing and inventory decisions together to improve overall performance of the system. More specifically, the supplier decides (i) when to replenish each customer, (ii) how much to deliver to each customer, and (iii) how to route delivery vehicles between the depot and the customers. In the setting studied in this paper, supplier's goal is to minimize total transportation cost over a planning horizon while avoiding stock-outs at the customer locations. We assume that the supplier has a fleet of homogeneous capacitated delivery vehicles and abundant availability of the product to be delivered to the customers. Each customer has a constant demand/consumption rate and limited storage capacity to keep inventory. In order to address this problem, we propose a novel integrated clustering and routing algorithm. In the clustering phase, we partition the customer set into clusters such that a single vehicle serves each cluster. In the routing phase, we develop the delivery schedule for each cluster. The novelty of the proposed approach is that it takes the three main decisions (when to deliver, how much to deliver and how to route) into account when partitioning the customer set and forming the delivery schedule for each cluster. We compare the performance of the proposed clustering and routing algorithms against the ones in the literature and obtain significantly better results in terms of both the number of instances that have been solved and the quality of the solution found. Since the proposed clustering approach is quite generic, we foresee that it can used for other routing problems as well.

Environmental Criteria in Public Tenders

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Keywords: Chain, Public Procurement, Public Tenders, Selection Criteria, Environmental Criteria, Multi-criteria Evaluation, Procurement Directives, Environmental Management Systems, Eco-Labels, Life Cycle Cost

A large portion of the Supply Chain activity is dedicated to Public Procurement. Public procurement (including works, supplies, services) accounts for 20% of GDP in stable economic conditions. That is why, in the context of Europe 2020 policies, emphasis has been placed on so-called "green public procurement". The goal is sustainable economic growth through public savings and, at the same time, reduction of the environmental impact of contracts awarded by public bodies.

Such objective is pursued through legislative provisions for environmental compliance clauses in contracts and for technical specifications specifically addressing environmental requirements in public tenders. The new Public Procurement Directives 2014/24/EU and 2014/25/EU particularly encourage the use of award criteria, which take into account not only the price offered, but also parameters such as the environment, through appropriate multi-criteria evaluation.

Specifically, the Directives refer to criteria either qualitative (eg emissions), economical (eg energy consumption) or involving the production process (eg use of Environmental Management Systems, Eco-Labels), which can be graded using weight factors and evaluated together with the offered price, in order to select the successful bidder. Specific reference is made to Life Cycle Cost as an independent criterion, which finds its scope in a variety of equipment applications.

The benefits of adopting the multi-criteria approach, especially with regard to the environmental aspect, are obvious: making use of innovation to develop new green technologies and production methods and enhancing the competitiveness of an economy that makes efficient and sustainable use of its resources.

The challenges? Informing the public bodies about the possibilities offered by legislation, developing appropriate market research tools and, at a regulatory level, adopting a set of best practices within the EU to avoid distortions and to achieve greater efficiency of the above measures, towards a circular economy where the value of resources is maintained for longer.

Risk Index in Economic Generation Operation in Power Systems with Renewable Sources

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Keywords: Transportation Costs, Logistics Model, Waste Transport, Network Structure

The transportation network and the respective input parameters play an important role in logistics planning. Especially in the location problems, the way of incorporating transport costs makes a big difference in the obtained results. Thus, the analysis of various cost approaches used in the operations models is needed. The paper presents the sensitivity analysis of transport cost with respect to other necessary input parameters related to the other costs and facility capacities. The resulting decision criterion is based on the multiple testing instances, which provide a deeper insight into the examined problem. The results serve as the hint prior to the model building whether to use detailed cost functions, how to design the transportation network and it also estimates the inaccuracy of outputs with respect to the chosen approach.

Periodic VRP Problem

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Keywords: VRP, Salesman, Mixed Integer, Vehicles

We present a new modeling and solution approach for the periodic vehicle routing problem (Periodic-VRP). Periodic-VRP is an optimization problem where a number of vehicles or salesmen need to visit a number of customers in order to deliver products or collects orders or pick up products. The salesmen have to visit the customers following a specific pattern of frequency. The customers are located in different geographic locations and the salesmen visit customers which belong only in specific region which is under his/her authority. The ultimate goal of the developed algorithm is to give each seller's plan, every day of the time horizon. The steps taken to solve this problem are: 1) The first step is to calculate the weighted center of customer points, 2) In the second step, the algorithm starts with a brief statistical analysis of the data that corresponds to customers 3) Create original customer clusters with a single objective, in this algorithm step, the quantification of a number of visits to each salesman 4) Develop a model of mixed integer mathematical programming that aims to transfer customers from one salesman to another salesman in order to achieve the best possible turnover for each salesman. 5) Re-assigment of customers to a different salesman and 6) Daily assigment of customers to salesman.

Water-Energy-Carbon Nexus Driven by Multi-regional Trade Network

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Keywords: Water-Energy-Carbon Nexus, Multi-Regional Input-Output Model, Linkage Analysis

Water stress, energy security, and threat of climate change have been aggravated by intense socio-economic activities along with complicated interprovincial trade network. As water consumption, energy generation and carbon emissions are intertwined with each other along the whole trading process, one vital issue is to coordinate resource utilization and emission mitigation considering their coupling mechanism along the multi-regional trade network, which can trace the shifting patterns of cross regional production that link geographically dispersed activities and actors of a single urban or sector. Such water-energy-carbon nexus (WECN) situation is becoming more complex. The identification of average propagation lengths can measure the distance between sectors in socio-economic trade networks, and the linkage analysis can evaluate the size the forward and backward linkages during the trade activities. The combination of these two methods provides a novel perspective to visualize the production structure in terms of WECN. This study evaluates the trade position of each sector along the national production chains as well as identifies the strong and weak WECN connection nodes and pathways in national economy. The results show that Beijing-Tianjin, Yangtze River Delta, and Pearl River Delta have shorter trade distance towards final consumers, and Western regions have longer trade distances towards final consumers. However, the embodied water and energy consumption, and carbon emissions in less developed regions are higher than those in wealthy regions. It reflects that developed regions are closer to the final consumers, gain large amounts of added values, and embraced with less environmental pressures. However, less developed regions are far from the final consumers, obtain lower added values, and bear with huge amounts of resource consumption and environmental pollutions.

Coordination in Decentralized Logistics Systems through a Multi-Period Game-Theory Model

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Keywords: Augmented Reality, Teaching Methodologies, Lecture, Virtual Reality, Innovative Tools, Innovative Lessons

The purpose of this presentation is to present methodologies for innovative teaching of lessons to save time in the creation of each lesson and a logical continuity from teacher to teacher. The first part refers to the differences between traditional and active learning methods. Then, reference will be made to innovative teachings and what principles the teacher must follow to apply innovative teaching to his lesson. Following that, will be the ten steps that everyone should follow to create their courses so that there is a logical continuation of courses from one professor to another and finally innovative teaching tools will be presented so that the student has an active participation in the course to maximize enjoyment and dedication, capturing the interest of students and inspiring them to continue learning

A Green Prize-Collective Vehicle Routing Problem for Sustainable Tourism

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Keywords: Prize-Collective Vehicle Routing Problem, Fuel Consumption, Firefly Algorithm

Globally, tourism has been described as fossil fuel-dependent industry, and hence, achieving sustainability in tourism has become an increasingly popular field of interest. More importantly, efforts are made to pursue sustainable transport in tourism, as a way to reduce CO2 emissions and greenhouse gases. Thus, the presented paper focuses on the sightseeing routing optimization in terms of fuel consumption efficiency. A number of Vehicle Routing Problem's (VRP) variants have been proposed in the literature to model the design of a tourist trip, such as the Prize-Collecting Vehicle Routing Problem (PCVRP). Assuming a set of points of interest (POIs), that each one is associated with a prize value, feasible sightseeing itineraries are to be formed with respect to capacity and travel time restrictions. According to the PCVRP formulation, these restrictions prohibit the inclusion of the complete set of POIs in a feasible solution, while the objective is the selection of a subset of POIs that maximize the total collected prize and simultaneously, aiming to the minimization of the total distance traveled. In order, to strive for efficiency in fuel consumption, this paper addressed a new variant of the PCVRP, namely the Green-PCVRP (GPCVRP). The proposed problem deviates from the original formulation in the second objective, i.e. the distance minimization, as it is replaced by the minimization of the total emitted CO2 emission level, as found in the literature incorporated in the majority of the Green-VRPs. The novel proposed formulation is solved via a hybrid Firefly Algorithm (FA), namely the Firefly Algorithm based on Coordinates (FAC). The presented FA hybridization is founded on the position, in the 2D-space, of each POI included in a solution, empowering the application of the update mechanism of the original FA, on non-probabilistic, continuous, problem-rated values.

Medical Waste Management in Region – A Complex Approach

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Keywords: Medical Waste, Waste Management, Process Integration, Waste Disposal Methods

The management of hazardous waste, especially medical waste, is an important topic that cannot be avoided. Treating medical waste in a correct manner can prevent possible dangers when moving or disposing the waste. Moreover, the amount of medical waste will rise with the increase in healthcare. Medical waste can contain a high percentage of infectious waste that has to be treated under special requirements.

This paper introduces a new complex approach in medical waste management at the regional level. All the important economic, technological and legislative factors are considered with the aim to specify the knowledge needed for a successful waste management project. This approach applies a trade-off between complexity and effectivity and includes a simple logistics, advanced producer and treatment plant models and simulation based optimization.

The technical description of current medical waste disposal methods is other goal of this study. The main methods are steam sterilization, incineration and shredding. These methods are described and compared with each other. Various indicators will be observed and studied, such as the possible type and amount of input waste, energy and time demands, output waste conditions and possibilities for further treating the output material.

Large Scale Integration of Renewable Energy Systems into Electricity Markets

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Keywords: Energy Systems, Power Systems, Energy Economics, Renewable Technology

Large scale integration of renewable energy technologies into electricity markets will require flexibility sources, independent of conventional generation, in order to provide standard security of supply. Together different flexibility sources will ensure the match between demand and supply at any given time. Energy storage systems can provide this flexibility by shifting the load temporally while transmission grids provide the shift of load spatially. Up to a certain extent, transmission capacity and storage capacity can replace each other, i.e. storage can reduce the load on transmission infrastructure by mitigating local peaks in load and/or generation. For the transition to a fully renewable energy system by 2050, major changes have to be achieved in the structure of the power system. The keynote speech will cover the future sustainable energy systems and strategies towards 2050 and the development of optimization models for the large-scale integration of renewable energy technologies into electricity markets. Such models are based on a unit commitment basis and the purpose of the optimization procedure is to assess the increase (or the benefit) in the cost of electricity of a given power generation system at different renewable energy sources penetration levels. Various scenarios will be presented including the use of energy storage.

An Ann Model for the Analysis and Forecast of Household Power Consumption

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Keywords: Artificial Neural Networks, Energy Efficiency

In developing countries, demand for power is rapidly increasing as populations grow and new technologies emerge. In order to respond the growing power need, new policies are to be designed to keep demand and supply in balance. Insight comprehension of the demand dynamics and underlying factors might bring light to different approaches in energy investments, energy generations and energy efficiency.
From this point of view, understanding the behavior of households is undoubtedly crucial. Over the last ten years, in Turkey, household power consumption has corresponded to more than 23% of overall power consumption. This study is focused on correlation of household power consumption and improvements in technology use or socio-economic factors. To analyze the impacts of individual factors on the power consumptions, household survey data is analyzed and key data sets are extracted using factor analysis and dimension reduction techniques. The key data afterwards is used to build a prediction model using Artificial Neural Networks (ANN). Finally, impacts of various household data are analyzed on the demand predictions.

Air Quality Monitoring Network: Optimize location of sensors

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Keywords: Air Quality, GreenYourAir, Sensor, Urban Environment, PM2.5

GreenYourAir team has developed an optimization model for the optimal design of a sensors network for the air quality monitoring of an urban environment in Volos city Greece. The design of the network was developed based on: 1) Residential zones; 2)Industrial zones; 3)Traffic conditions zones; 4)Potential sources of PM2.5; 5)Natural gas network; 6)Combustion of waste or wood; and 7)Weather conditions. Additionally the city of Volos was divided on 8 zones where the optimal location and optimal number of sensors has been defined maximizing the sensors coverage. In total, 12 sensors have been installed in 12 different locations in Volos city and start their measurements period on March 2019. The network will monitor the level of PM2.5 for a period of 12 months in order to consider the combination of all different conditions (e.g. winter with traffic and high humidity, summer without traffic and hot weather, high wind velocity etc.). In parallel, GreenYourAir network collect medical data in order to collate them with the level of PM2.5. This data includes the pulmonary incidents (e.g. asthma, COPD etc.), the cardiovascular events (e.g. infarction), the pediatric incidents (e.g. upper respiratory tract infection (URTI)), the pathological incidents (e.g. cough), as well as the origin of the event (i.e. the location of patient) the time and date of the event.

Smart/Green Manufacturing and Sustainability

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Keywords: Thermal Storage, Sand-bed, Cold Region, Renewable Energy

Smart manufacturing is the fourth industrial revolution. With advances in information and telecommunication technologies, energy systems and data enabled decision making, smart manufacturing can be an essential component of sustainable development. This talk will focus on the problems arising in manufacturing and energy systems as well as recent advances in optimization, modeling, and data sciences techniques to address these problems. In addition, we will discuss future research directions and new challenges to society.

Grid and Dispatch in South Eastern Europe

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Keywords: Power System, Energy System, Grid and Dispatch, Short-Term Optimization, Long-Term Model Validation, PLEXOS

In present paper research results obtained within framework of H2020 REEEM project are given. PLEXOS Simulation Software is used to develop model of power systems in five South East Europe (SEE) EU member states - Bulgaria, Croatia, Hungary, Romania and Slovenia. The aim of the research was to investigate if results obtained from a long-term energy system planning model are feasible and realistic in the scope of short-term modelling with an hourly time step for one selected year (2030). According to the outline of the REEEM project, several EU transition pathways are developed. Results of Integrated European Systems Model based on TIMES PanEU for Base and HighRES pathways are used as inputs to PLEXOS. In terms of scope of this research, HighRES pathway represents a greater challenge for grid and dispatch analysis compared to Base pathway, due to higher electricity demand and lower installed generation capacities in SEE region. Three scenarios are developed under each pathway according to different assumed constraints on electricity generation and cross-border electricity exchange. In total, six scenarios are analysed in order to verify feasibility of grid and dispatch on an hourly level, and also to compare results of short-term power system optimization with long-term energy system optimization. Results of all analysed scenarios show that power system in SEE region in 2030 can be dispatched on the hourly level. Paper also addresses the differences in modelling results of short-term optimization of power system compared to long-term optimization of entire energy system. Aside from the conclusions on grid and dispatch for all analysed scenarios, key messages regarding feasibility and influence of Base and HighRES pathways on power systems of SEE region are extracted in the paper.

Contribution of IRENA in Global Transition to Renewable Energy

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Keywords: IRENA, Energy Transition, Renewable Energy Policies

Energy sources used by human being have shifted from renewables to coal, oil, and finally natural gas since the Industrial Revolution. Fossil fuels have provided cheap and continuous energy for the development of civilizations for more than a century and a half. However, because of their irreversible effects on global climate change and natural environments, and exhaustible nature, a transition to a more sustainable energy regime now became inevitable. This new regime is based on decreasing final energy consumption by increasing efficiency on one side and allocation of more renewable energies on the other. However, considering the present share of renewable energy including hydroelectricity is only 10.4% of the world's energy mix, the transition is usually expected not to be easy and smooth. The past experiences showed how painful this paradigmatic shift could be. International cooperation is required to speed up for a global transition, and international organizations can help states to form sound national policies and their implementation. In this context, IRENA was established by a group of countries in 2009 to build an international platform to support countries in their energy transition by creating renewable energy governance around the world. With its initiatives started in the last decade, IRENA managed to create renewable energy norms internationally and locally for the internalization of renewable energy deployment. By evaluating its activities with the social constructivism approach, it can be concluded that despite its short existence, IRENA's efforts to create norms were successful, but the agency needs to spread its initiatives more equally around the world so that these norms become truly global. For a better transition, every country needs to improve its renewable energy policies, and this may only be possible for states to form a common identity on the internalization of renewable energy norms.

Biomass Briquettes from SRC Plantation - Economic and Environmental Aspects of Usage for Local Space Heating

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Keywords: Biomass, Economic Efficiency, Biomass Briquettes

Biomass contributes significantly to the total amount of energy from RES in the Czech Republic. In recent years, the share of biomass used by heating households has increased. At the 2030 and 2040 horizon, further growth in the role of biomass in replacing fossil fuels for local residential heating is expected (an increase from 79 PJ to 92 PJ). There is currently a rapid depletion of the residual biomass potential. Therefore, it can be assumed in the future that the intentionally cultivated biomass on farmland will play a key role. The paper focuses on the analysis of the substitution of fossil fuels used for heating family houses by locally cultivated biomass from SRC plantations processed into wood briquettes. The produced briquettes will serve primarily as a substitute for brown coal, which is still massively used for individual heating, especially in older buildings (about 300 thousand households).
The paper presents research results focusing on the analysis of the economic efficiency of the entire biomass briquettes fuel cycle from the production of raw biomass to the supply of briquettes to end users. From the economy of briquettes production, the primary aim was not to generate profits, but to secure local fuel needs (this is also the lower value of the discount used in economic calculations) and environmental benefits for the agricultural landscape in the given locality. The results of the calculations show that the competitiveness of briquettes produced in this way can only be achieved if there is a significant increase in the support for the production of biomass (dubbing the specific support per hectare - SAPS) or a substantial increase in the environmental tax imposed on coal (ca 10x to 3.3 EUR / GJ).

The Earth's Dominant Climate Driver: CO2 from Fossil Fuel Combustion and Other Anthropogenic Activities

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Keywords: CO2 Emissions, Global Trends, Climate, Anthropogenic, Emissions Hotspots, Paris Agreement

A part of the Paris Agreement is the transparency framework to be implemented bottom-up based on the national greenhouse gas (GHG) emission inventories reported to the United Nations Framework Convention on Climate Change (UNFCCC) by all Parties; however, the reported inventories cover neither the entire globe, nor the entire period. The European Commission's in-house Emissions Database for Global Atmospheric Research (EDGAR) estimates all anthropogenic greenhouse gas emissions on a country-by-country basis thereby contributing to enhanced transparency and completing the global picture with time series for each country starting in 1970.

We estimated the CO2 emissions associated to fossil fuel combustion and other man-made sources such as gas flaring, steel and cement clinker production for all countries from 1970 up to 2017 by using recent energy consumption and industrial production statistics. Global CO2 emissions increased 1.2% in 2017 compared to 2016 reaching 37 Gt CO2, of which EU28 is responsible for 10% being one of the major emitting economies together with China (29%), USA (14%), India (7%), Russia (5%) and Japan (4%). The CO2 emissions within the EU28 have decreased by 16% since the Kyoto protocol took into effect (2005) despite global increasing trends during this period due to the higher contribution of emerging economies. In 2017, the CO2 emissions per capita within the EU28 was with 7 ton CO2/cap/year the lowest among the largest emitting countries, except for those of India, which were about 2 ton CO2/cap/year, while the global average was 5 ton CO2/cap/year. The power generation, transportation and small residential combustion sources are among the key contributors to EU28 emissions.

Challenges regarding emissions mitigation will be presented based on our findings recently published in "Fossil CO2 emissions of all world countries; 2018 edition" and a description of the areas with elevated CO2 emissions on the EDGAR global grid maps will be provided.

Heavy Metal Contamination and Sustainable Emission Reduction in Energy Conversion with Contaminated Biomass and Waste fuels

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Keywords: Building Integrated Photovoltaics (BIPV), Net Zero Energy Buildings; Integrated Design

Recycled woods and combustible municipal solid waste have been considered as important biomass fuels used for energy (power) generation in Sweden and EU countries due to improved recycle/separation of sources for waste-to-energy and relatively low fuel costs. In comparison to conventional biomass fuels recycled wood and waste fuels are often enriched with certain contaminants e.g. heavy metals and metalloids. Sustainable reducing the impacts of heavy metals is an essential environment issue for this bioenergy conversion. In this paper, a comprehensive analysis has been made for the impacts of heavy metals on emissions from biomass-fired combined heat and power plants (CHP) and waste incineration units in terms of contamination characteristics, retention of heavy metals in specific emission reduction processes, and cross-media effects. A comparative evaluation is performed for a new concept implemented with best available technologies in comparison traditional approach, by which the potential of sustainable emission reduction is investigated for heavy metals and metalloids in combustion of contaminated biomass and waste fuels.

Contamination sources of heavy metals and metalloids in recycled woods and municipal solid wastes were continuously changed with the developments in waste separation, material recycling and waste-to-energy in recent decades. There is no significant reduction in the contamination levels in recycled wood and waste fuels due to different end-life of consumer products, but contamination sources become more complicated. Traditional emission reduction processes may not be suitable to handle the contaminants from complicated sources. An effective flue gas cleaning can well control the heavy metal emissions to air and water streams, which make the impacts on emissions less sensitive with fuel contaminations.

Sustainable emission reduction of heavy metals and metalloids has been investigated through new concepts: (1) optimization of cross-media effects in a closed water loop in the energy conversion processes to eliminate the heavy emissions to water streams, and to enhance internal water utilization and minimize wastewater discharge, and (2) integration of new separation process to achieve energy- and cost-effective separation process for metal and salt recovery. Initial investigation shows both concepts are promising for further development.

Sustainable Digestate Treatment in Biogas Plants

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Keywords: Biogas Plants, Sustainable

An effluent treatment is one of the major tasks for biogas plant operators. If the treatment is expensive due to transport and application costs it is possible to apply a mass reduction technology and decrease transported amount. Evaporation is one of such technologies. However, the distillate from evaporation process still contains substances, ammonia in particular, which disables its discharge to surface water. Stripping process might be used to remove ammonia and other unwanted substances. The preliminary tests indicate that newly designed evaporator-stripper system can be successfully applied for liquid digestate treatment.

Monitoring the Environmental Impact of GreenYourMove Project

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Keywords: GreenYourMove, CO2, GYM Platform, Emission

The scope of this research is to monitor and measure the GreenYourMove (GYM) project's impact on the environmental. A monitoring protocol was established based on a novel emission inventory methodology, which was applied in the Greek transport network so as to assess the environmental impact. GYM platform was expected to encourage car drivers to use more often public transport and reduce the use of passenger cars. This was achieved by promoting co-modal and environmental efficient transport patterns. Thus, the expected CO2 emission reductions was calculated during the project lifetime. Firstly, a monitoring methodology for environmental impact was developed taking under consideration a several new factors. Then a data collection for specific check points was applied in order to access the impact of specific activities of GYM project. Final, the quantification of environmental impact was implemented in order to define the overall impact of the project.

Research on the Production of LNG and Liquid Hydrogen from Industrial By-Products Containing Hydrogen and Methane

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Keywords: Liquid Hydrogen, LNG, Cryogenic System, Energy Integration

In the process of industrial production, gas mixtures with methane-hydrogen as main valuable components are often obtained as by-products. A cryogenic liquefaction and separation system is proposed and investigated in this paper. Assuming that the other impurities are removed previously, high-purity liquefied natural gas (LNG) and liquid hydrogen can be produced from these gas mixtures at the same time. The whole system is composed of three parts: (1) cooling and condensation of methane-hydrogen mixture, (2) mixture separation, and (3) hydrogen liquefaction after separation. The mixture is firstly cooled and partially condensed by liquid nitrogen in the first part, and then it is introduced into a distillation column (part 2), where it is separated into methane and hydrogen. LNG is the liquid product produced from the bottom of the distillation column. A multi-stage hydrogen expansion refrigeration system is established in the third part to liquefy the separated hydrogen. The three parts achieve excellent energy integration. The heat needed by the re-boiler of the column, as well as the heat needed to be extracted from the re-condenser of the column in part 2, are all integrated with the hydrogen expansion refrigeration process (part 3). The unliquefied cryogenic hydrogen from part 3 as well as liquid nitrogen together provide the cooling capacity for the condensation of the mixture in part 1. Energy consumption as an objective function is optimized in terms of several key operating parameters. Process simulations are performed by the software ASPEN HYSYS, and P-R equation of state is used in the simulation. Based on the optimization results, the effects of the liquefaction rate and hydrogen-methane recovery rate on the process performance are investigated. The results show that the energy consumption for the system reduce by 43.9% compared with the traditional process to produce the same amount of products.

Integrating Industrial Processes with Neural Learning

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Keywords: Deep Learning, Pointer Networks, Process Integration, Process System Engineering, Heat Exchanger Networks, Process Networks

Process integration problems are traditionally solved using graphical pinch analysis and automatic targeting method. Evolutionary methods such as genetic algorithms, particle swarm optimization and simulated annealing can also be used to speed up the computation of process integration problems by compensating the optimality of solution. In this work, the deep learning approach towards solving process integration problems is proposed. Multiple heat exchanger networks are randomly generated using a novel generative model and integrated using a fast Bayesian optimization algorithm. These integrated heat exchanger network datasets are used to train a sequence-based neural network. The proposed pointer network attempts to learn the sequence-based integration of heat exchanger networks during training phase. In the subsequent inference phase, the pointer network is shown to be able to integrate heat exchanger networks that are significantly larger than that of the training set. This demonstrates that the neural network learns the method to integrate a heat exchanger network instead of memorizing sequences of integrated heat exchanger networks. Another advantage of using such deep learning method is that further heat integration problems can be solved in a linear computation-complexity, hence speeding up computation time for integrating larger heat exchanger networks. A comparison study between methods is carried out to demonstrate the performance of pointer networks in carrying out process integration problems.

Sustainable Timetable for Public Transport

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Keywords: Public Transport, Timetable, Shift

In public transport the timetable of the trips is critical for both the quality of service offered to passengers and the operational cost. These two sides are opposing one another as more frequent trips lead to better service to customers but increase the operational cost of an agency. In the current research, the approach used for the timetable construction and realization is split into three stages. The first one is the derivation of the frequency of the trips during the day, the second one is the assignment of the trips into bus and driver shifts and the third one is the scheduling of the shifts undertaken by specific buses and drivers. In this work the authors study the second stage of the creation of the shifts, taking into consideration the time of the trips as predefined. The problem is formulated as a Mixed Integer Linear Problem with the objective function of minimizing the overtime cost derived by all the shifts. The developed mathematical model includes constraints such that all trips are assigned to shifts, every driver shift should have a break of specific duration and time overlapping constraints between the trips. Also, it includes binary decision variables like the ones of assigning a trip to a shift and continuous variables for computing the time each shift starts and finishes. The mathematical formulation is applied to the public bus transport agency of the city of Volos in central Greece with promising results.

A Multicriteria Assessment Approach to the Energy Trilemma

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Keywords: Climate Change, Energy Policy, Energy Trilemma, Multicriteria Decision Making

The concept of the energy trilemma provides a framework for supporting energy policy decisions based on three main dimensions, namely energy security, environmental sustainability, and energy equity. Contrary to models that focus on providing policy guidelines solely based on normative grounds, energy trilemma adopts a descriptive perspective that emphasizes the need to monitor and assess the observed results of energies policies and of all externalities that affect the status of a country and the challenges that it faces regarding energy planning.

Building on the grounds of the energy trilemma concept, the objective of this study is to introduce a comprehensive framework and an evaluation process for operationalizing the assessment of the counties' performance from the energy trilemma point of view. To this end, first we describe the context of each of the main energy trilemma dimensions and suggest relevant indicators for each of them. We view energy security focusing on energy dependence and resilience, energy sustainability is considered in the context of energy use, energy efficiency, and environmental impacts, whereas energy equity is analyzed from the perspective of income availability and energy poverty. Moreover, we enhance the trilemma concept with a fourth dimension to account for the contextual environment of the countries, which is described in terms of their economic development, policy regulations, and innovations in energy and environmental technologies. This framework is operationalized through the consideration of 20 indicators using data from the World Bank and the OECD. The selected indicators provide a "bottom line" view for the context of each dimension regarding the current status of the countries, their existing strengths and weaknesses, as well as the challenges that they face, incorporating information for both the outcomes of policy decisions as well as external (uncontrollable) factors.

The aggregation of the indicators provides composite indicators for each one of the four dimensions describe above, as well as an overall assessment. The construction of these composite evaluations is performed using a multicriteria approach, which is based on principles from efficiency measurement. More specifically, a variant of the envelopment analysis is introduced to evaluate the countries in a data-driven context. Under this scheme, the performance of a country is measured in terms of its distance from a best practice frontier that is defined by the observed data of a set of countries. The assessment combines an optimistic perspective, which emphasizes the dimensions where a country performs best, as well as a pessimistic point of view that focuses on the weaknesses of each country. This data-driven approach overcomes difficulties associated with the specification of specific (subjective) weights for the indicators, while providing flexibility in the evaluation process, by allowing the consideration of country-specific trade-offs among the trilemma dimensions, based on the characteristics that best describe the observed data of each country compared to its peers.

To illustrate the proposed methodological framework and the multicriteria approach for the construction of composite indicators for measuring the performance countries in accordance with the energy trilemma concept, empirical results are presented for OECD countries over the period 2005-2015. A rolling window approach is used to explore the dynamics of the countries' performance and the identification of time trends. The results show that Scandinavian countries tend to utilize a relatively balanced and more independent energy mix compared to other OECD countries. Energy sustainability has improved steadily during the period of the analysis, driven by the increasing use of clean energy technologies and the improvements in energy efficiency. However, there is still work to be done in energy equity, as this dimension remains challenging. Overall there is improvement over time.

Development of a Framework for Electricity Generation Expansion Planning with Multiple Objectives under Uncertainty

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Keywords: Electricity, Generation, Multiple Objectives

This study is aimed to develop a framework for electricity generation expansion planning considering conventional and renewable technologies and with demand growth uncertainty. The impacts of possible energy, economy, and environmental policy decisions The uncertainty in annual electricity demand was checked with the correlated Geometric Brownian Motion process. A number of scenarios were constructed with matching method and simulations were carried out with Monte Carlo simulations. Cost and technical performance of conventional and renewable power generation means also accounted for decision making. A realistic case was studied considering Turkish electricity generation industry. The developed framework could be utilized by policy makers to analyze different scenarios based on economic and environmental parameters in order for decision making for future generation expansion planning in case of uncertainties.

Experimental Validation of a CFD Model for Spiral Ground Heat Exchangers

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Keywords: CFD Model, Renewable Energy

With the recent advancement of Renewable Energy Systems, one such expression – Shallow Geothermal Energy – frequently finds application in the form of Ground Source Heat Pumps (GSHPs). GSHP systems are used for space heating and cooling via tubes directed into the ground. Vertical Ground (or Borehole) Heat Exchangers (GHEs) with different configurations (mainly of U-tube, double U-tube type) extract or reject heat into the ground. Spiral or Helical type GHEs have been introduced as an alternative to reduce the depth and hence the cost of GSHP systems. It was only recently that such GHEs have been used in the foundation piles, identified as Energy Piles. Energy piles are reinforced concrete foundations with helical pipes whereby the buildings foundations are utilized to provide space heating and cooling. In general, the sheer experimental set-up and testing of a GHE is expensive and time consuming, therefore computational investigation is preferable. To this end the current paper introduces a three-dimensional mathematical model using the COMSOL Multiphysics software, based on the convection-diffusion equation. The related parameters are adjusted to present actual parameters taken from experimental data. Hence, the computational model is validated against available experimental data. The validated model is subsequently adapted to match the Mediterranean conditions in Cyprus. An investigation of the important implications of the design of GHEs, such as variable pitch length and spiral tube length is also conducted.

Ground Thermal Characteristics of Typical Soils in Cyprus for Ground Heat Exchangers

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Keywords: Geothermal Energy, Soil, Ground

Shallow Geothermal Energy Systems (SGES) rely on exchanging energy between the building and the ground. This is achieved with Ground Source Heap Pump (GSHP) systems by utilizing Ground Heat Exchangers (GHEs). GHEs are essentially a network of pipes installed in the shallow depth of the ground responsible for extracting or rejecting heat to and from the ground.
The thermal characteristics of the ground affect the rate and the performance of the GSHP and, hence, such information is vital for designing a GSHP system. Such characteristics include the thermal conductivity, the thermal diffusivity and the specific heat capacity and can be obtained by using empirical prediction models, laboratory tests and in-situ tests.
This paper presents Laboratory thermal tests, which have the advantage of requiring less time, small volume of soil, and reduction in cost. Evaluation of thermal properties is achieved by using two commercially available transient needle probes; namely the Isomet-2104 and Hukseflux-TPSY02 and one surface probe by Isomet-2104. A comparison on the testing and the accuracy of the equipment is presented. Furthermore, a numerical modeling solution using COMSOL Multiphysics software is presented and validated against the experimental data.

Temperature Regulation of Polycrystalline Silicon Photovoltaic Panels with Movable Thermal Energy Storage Units Filled with Phase Change Materials

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Keywords: Photovoltaic, Phase Change Material, PV/PCM System, Temperature Regulation, Photovoltaic Performance, Outdoor Experiments

This paper presents an experimental study to evaluate the improvement of photovoltaic (PV) performance through temperature regulation of a commercial polycrystalline silicon PV panel, by placing a movable thermal energy storage (TES) unit filled with a free-form commercial paraffin-based PCM (RT22HC) on the panel's back. The outdoor apparatus is located in Coimbra, Portugal (40.19N, 8.42W). Three identical PV panels were separately installed and individually monitored: one panel was taken as reference; the other two were considered together with a TES unit each, forming new PV/PCM systems. Regarding the TES unit, two configurations were tested: aluminum container with vertically (PV/PCM1) and horizontally (PV/PCM2) oriented rectangular cavities. The time evolution of the temperature of the PV panels was compared with each other to analyze the effective thermal regulation potential of the TES units. The time evolution of the power output was also evaluated to compare the efficiency of the different systems.

Renewable Energy Systems: Current Status and Prospects

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Keywords: Renewables, solar, wind, photovoltaics, biomass, hydro energy

The purpose of this paper is to present the worldwide status of the various renewable energy systems (RES). This is presented in terms of the total installed capacity of the various types of RES by the end of 2018 and is based on the reports of various international agencies and organizations. The paper initially examines the effects on climate that the use of human activities has and a review of the status of the existing conventional fossil fuels and their expected depletion based on the existing resources and the current rates of consumption. The types of RES examined include the main and most important, in terms of capacity, i.e., solar thermal, solar photovoltaics, hydro systems, wind energy systems and biomass, biogas and biodiesel. Other forms of renewables like ocean energy systems, geothermal and hydrogen and fuel cells are just mentioned. In each type of RES examined in addition to the total installed capacity the status of the technology is given as well as the outlook in terms of prospects and the current research areas. In can be concluded that although the total installed capacity of RES is small, relatively to the total conventional annual fuel consumption, this constitutes an important environmentally friendly solution to protest the planet with very good prospects of expansion in the coming years.

Effect of the Spatial Variability of Soil Properties on the Seismic Vulnerability of Slopes with Embedded Oil and Natural Gas Pipelines Pumps

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Keywords: Vulnerability, Seismic Performance, Spatial Variability, Random Fields, Numerical Analysis

Numerous oil and natural pipeline systems passing through geohazard areas all over the world are vulnerable to seismically induced slope instability, large ground displacements and settlements. Such ground movements pose major challenges for the pipeline structural integrity and safety, as well as for environmental safety in case of wall rupture and loss of containment. The intensity and the spatial distribution of the imposed ground movement may depend significantly on the spatial variability of the soil properties in a zone along the path of the pipeline system. The presented research aims at accounting in a rational way for the effects of the spatial variability of the soil properties on the seismic performance of buried oil and natural pipelines passing through natural slopes. More specifically, the effects of spatial variability of soil properties, slope inclination and earthquake excitation characteristics on the development of permanent displacements are investigated using random fields created by the Local Average Subdivision method by Fenton and Vanmarcke (1990). These random fields of soil properties are characterized by specific mean, variance, cross-correlation coefficients and autocorrelation lengths and used for performing a series of seismic analyses of various slopes using the finite difference software FLAC in a Monte Carlo simulation methodology. The results of an extensive parametric investigation allow the development of vulnerability curves, based on the permanent horizontal or resultant displacement for several seismic intensity levels. The results demonstrate that the influence of spatial variability of soil properties on the ground movement imposed on the embedded pipeline are very important and should be accounted for in the evaluation of its seismic safety.

Dynamic Simulation of a Drum-Type Boiler Considering the Stress inside the Steam Drum Shell

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Keywords: Dynamic Simulation, Drum Boiler, Thermal Stress

A mathematical model is developed to simulate the transient behavior of a natural circulating drum-type boiler. The model is derived from the first principles of mass, energy and momentum conservations. The thermal stress within the drum shell is quite important as it can affect the performance of a drum boiler. In other to calculate the thermal stress distribution, a stress sub-model is adapted which is based on the discretization of the Fourier's heat conduction equation. The dynamic changes in the drum pressure and the drum water level are simulated during the special transient operations of a fluidized bed combustor like start-up period, shut-down period, and load change period. By the drum pressure simulation result, the drum wall temperature is determined. After that, the temperature distribution in the drum shell can be predicted. The temperature distribution is used to calculate the stress distribution in the drum shell at each time step. The simulation result of drum pressure shows a good agreement with the process measurement data.

Testing of the First PTC System in Cyprus' Biggest Soft Drinks Factory: First Operation Testing and First Short Period Performance Investigation

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Keywords: PTC, Steam, Industry, Parabolic, Storage

Industrial sector is the second biggest fuel consumer in Cyprus, used mainly for the purpose of steam production. Manufacturing itself, comprises the 60% of the whole amount of fuel consumption. Knowing that the ratio of direct to diffuse solar radiation in Cyprus is 70:30, a parabolic trough collector system (PTC) would be the perfect system for thermal energy production in higher temperatures than the ones can be achieved from the already widely used flat plate collectors in the island. This can be supported by the fact that Cyprus is 100% dependent of imported fuel. The use of PTC systems for the production of steam or hot water, can reduce the fuel consumption, if the main requirements for the use of such system can be reached. The main and most important requirement is the space availability. The last two years Cyprus University of Technology (CUT) participated in an EU funded project, where with known manufacturers and companies around Europe, managed to install the first industrial PTC system in Cyprus. This is installed in the biggest soft drinks factory in Cyprus, called KEAN. The system consists of two series of four CF100 PTCs, a Steam Generator (SG) and a concrete thermal storage (C-TES). The purpose of the C-TES is to keep the system dispatchable and satisfy the required thermal needs even in winter period. The system is operating in different operation modes and is controlled automatically by the main processor. In this paper the data of the first operation measurements have investigated in order to evaluate the operation of the system. After a month of continuous operation, a performance analysis of the system has been done to evaluate the effectiveness of the CF100 collector and the SG. The performance of the system was estimated in relation with a real-time weather data collected by the on-site weather station. Finally, after several months of reflectivity measurements in different weather periods, the dirty coefficient is also calculated.

Techno-economic Assessment of Pathways to Net-Zero Energy Houses

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Keywords: Net-Zero Energy, Houses, Technoeconomic Assessment

Of all secondary energy consumed in Canada, approximately 17% is consumed by the residential sector. Efforts to reduce this energy consumption and the associated emissions include the replacement of traditional housing with passive and net zero energy house designs. These two concepts involve the decreasing of heating and cooling loads as much as possible through high performance enclosures and high efficiency mechanical and electrical systems as well as, in the case of Net-Zero Energy Buildings (NZEBs), offsetting these small loads with their own on-site renewable energy generation.

An effort has been made to evaluate the techno-economic feasibility of achieving NZEB status for a new construction, detached, single family residence in the province of Nova Scotia, Canada. This is achieved using a combination of energy modelling software to estimate energy needs for proposed home designs as well as estimating the prospective monetary costs of proposed home designs. The energy modelling software "EnergyPlus" is the primary energy modelling software utilized in this research. The energy use and cost evaluations are compared to a "base case", an approximation of a current typical new construction four-person home in Nova Scotia.

The base case home and subsequent upgrades are modelled for both energy use and cost for three distinct locations in the province. Based on the costs and energy savings associated with each potential upgrade, a pathway to achieving a net-zero energy home for all three locations is developed.

This paper presents the methodology developed for this work as well as the results obtained.

Performance Investigation of a Ground Source Heat Pump System for Space Heating and Cooling of a Typical House in Moderate Climates

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Keywords: ASHP, Ground Source, Heat Pump System, Energy consumption

Air Source Heat Pumps (ASHPs) are commonly used for the air-conditioning of buildings. They practically use the atmosphere as a heat source/sink to absorb/reject heat. A Renewable Energy System (RES) that exploits the ground to absorb/reject heat from the building is called Shallow Geothermal Energy System (SGES). The ground temperature is always lower in the summer and higher in winter compared to atmospheric air temperature. In such systems, the usual tool are Ground Source Heat Pumps (GSHPs) that are employed to further increase the heat pump efficiency and reduce the required electricity.
The evolution of the SGEs has led to competition with the ASHPs and the manufacturing of custom designed inverter technology ducted series HPs. It has also initiated the debate whether it is economically feasible to install GHEs as an alternative to the custom designed HP. This study presents such a case with the introduction of a typical house in moderate climate (Cyprus weather conditions) by using an experimentally validated Computational Fluid Dynamics model.
Different water inlet temperatures are examined for both summer and winter. The system efficiency is discussed in relation to the power rejected to the ground and the length of the GHE. Finally, a system cost analysis is presented for different length GHEs and a comparison of the total energy savings is obtained. The GSHP systems, although providing a sustainable and higher performance when compared to custom designed ASHPs, are proven to still fail to be a viable investment.

SEASON, Self-lEarning and self-Adjusting Smart thermOstat for energy demand prediction and optimizatioN in buildings and districts

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Keywords: SEASON, Energy, Demand

Buildings consume between 35% and 40% of the total energy in EU countries with 35% up to 70% of this amount used for indoor heating and cooling that is far from 2018 European directives for buildings energy performance. EU considers the importance of new technologies and control systems to achieve this goal and it encourages the use of ICT and smart technologies to ensure buildings operate efficiently by introducing automation and control systems. In addition to an efficient heating/cooling system and the renovations in constructions, using advance control strategies and artificial intelligence techniques improves the thermal performance of buildings significantly. Although new products are commercialized for home automation purposes, they lack the proper implementation of machine learning techniques for modelling the system and make energy consumption predictions in order to optimize energy demands at building and district levels. In this work we suggest a smart device (thermostat) that implements machine learning techniques for data processing, modelling and simulation of buildings. The device is able to connect and make detailed observations on various part of a building through its modular structure. The artificial intelligence algorithms are adapted to work on low memory devices in order to reduce computational costs and improve home automation purposes.

Innovative Compressed Air Storage Concept

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Keywords: Compressed Air Energy Storage (CAES), Energy Storage

A novel compressed air energy storage (CAES) concept is introduced, which is based on the utilization of already compressed air for industrial scale storage applications. The patented new CAES concept enables to time-shift the required power of compression, thus optimizing the power consumption of industrial sites for example with regards to the share of renewable energy, or electricity cost. The presentation will show results of thermodynamic simulations of the charge and discharge cycles, as well as estimations of storage size and cost.

Layout Optimization of Existing Waste Water Network in Luxembourg

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Keywords: Process Optimization, Synthesis, Design and Operation, Mathematical programming

Fresh water tends to increasingly comprise a scarcity today both in arid or even demographically boosted regions of the world such as large and smaller cities. Mathematical modeling of waste water networks (WWN) involves writing water flow balance and contaminant mass balance equations around the water using processes and the treatment processes. Optimization on above mentioned networks concludes in minimization of fresh water with respect to the above equality constraints and several inequality constraints regarding the maximum inlet and outlet concentration of flows of a process. In general wastewater minimization problem of multiple contaminants can be formulated as a Non Linear Programming (NLP) problem. However in order to reduce the freshwater usage and the cost we have to minimize two or more objective functions or formulate the problem as a mixed integer nonlinear programming problem, using binary variables representing streams between the units. For these kind of problems genetic algorithms can provide better solutions avoiding local minimum or/and providing the pareto front. The present model attempts to optimize existing waste water network of Luxembourg in the local and/or national scale. The case study of districts within the City of Luxembourg is examined, where a possible re-design of an optimized Waste Water Network comprises an essential task within the context of contemporary problem of large scale demographic growth within urban networks. Potable water production in Luxembourg is sourced by ground waters at 2/3 and surface waters at 1/3. Ground waters are obtained from springs and wells. Surface waters are obtained by treating the waste waters by waste water plants. These water flows are mixed before being delivered to the customer. This requires larger waste water treatment capacities and/or improving existing plants and/or constructing the new ones. The model aims to find thus an optimal re-location and/or the optimized number of waste water plants.