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Thursday, April 21

Thursday, April 21 8:00 - 9:00 (America/Los_Angeles)

OPK1: **Opening Remarks & K1: IOT and sustainability**

Keynote: IOT and Sustainability

Adam Drobot, Chairman, OpenTechWorks Inc.

Room: Ballroom

Chair: David Gonzalez (IEEE, USA)

Opening Remarks and Introduction: Kathy Herring Hayashi, IEEE Region 6 Director-elect

Keynote: "IOT and Sustainability"

Adam Drobot

Much of the popular discourse about sustainable development centers on the framework defined by the Brundtland Report [1]. The report addresses the future of human existence on the planet and the impacts on society, the environment, culture, and economics [2]. The hoped-for results are described by the Sustainability Development Goals [3] that relate a more granular view to desirable, but still vague, traits, behavior, and outcomes. The underlying issues are inherently complex and tangled. The Internet of Things (IoT) and accompanying infrastructure and technologies provide tools for improving our understanding of the state of the planet, the consequences of decisions, resource allocations, and the dynamics that drive outcomes across the SDGs. What I will cover in the talk is Sustainability, the Internet of Things, how the two are related, and in-depth examples that relate how technology can translate into positive outcomes and results. The examples address three important problems and include the application of IoT to Agriculture, Smart Cities, and Cultural Dynamics.

Thursday, April 21 9:10 - 10:30 (America/Los_Angeles)

PS1: Agriculture and Food Technology

Room A

Chair: Rakeshkumar Mahto (California State University, Fullerton, USA)

9:10 ***Anomaly Detection at the Apiary: Predicting State and Swarming Preparation Activity of Honey Bee Colonies Using Low-Cost Sensor Technology***

Diren Senger, Carolin Johannsen and Thorsten Kluss (University of Bremen, Germany)

Contemporary apiary practices rely on frequent manual inspections of the beehive to be able to notice undesired states of the bee colony early enough to react with an adequate measure. However, the

inspections themselves may harm the bees and their success heavily depends on the beekeepers experience.

We propose an approach for an automated prediction of anomalies in honey bee colonies that focuses on swarming events as well as the colony's health state using a low budget DIY sensor setup, and compare methods from the domain of time series clustering.

Our results show that our approach enables detecting signs of a swarming event 48-24 hours before it occurs with an accuracy that is helpful for beekeeper's daily work. This facilitates the development towards an efficient, minimally invasive precision beekeeping practice.

pp. 1-7

9:30 *Analysis of Long-Term Sustainability Challenges & Optimization of Solar Thermal Lemongrass Essential Oil Extraction Systems*

Aroun Clément Baudouin-van Os (Amrita Vishwa Vidyapeetham, India); Maneesha Vinodini Ramesh (Amrita Vishwa Vidyapeetham, Amrita University, India)

Solar thermal lemongrass (Cymbopogon flexuosus) essential oil extraction is a potential sustainable livelihood for the Indian rural population. In this work, an extensive review of existing extraction techniques, their performances, fitness to the context, as well as sustainability and efficiency factors has been elaborated. While microwave assisted methods can reduce the extraction time and increase the yield, it is at the cost of added complexity and dependency on electric energy, which can be unfit for communities that experience scarce supply. It is required to measure the performance of the microwave hydrodiffusion and gravity (MHG), and microwave steam diffusion (MSDf) methods with the lemongrass genus to verify their advantage over steam distillation, which in the study's context remains the favourite. The study has unveiled that four key factors need to be considered for ensuring the sustainability of the livelihood: (a) implementation price, (b) operational price, (c) energy consumption, and (d) extraction time. Essential oil extraction can be optimized by six different categories of efficiency factors: (a) post-harvesting drying, (b) plant rehydration, (c) plant chopping size, (d) water to grass ratio, solid loading or plant packing, (e) temperature, steam heat, pressure and airflow, and (f) microwave power.

pp. 8-15

9:50 *Feasibility of Achieving Net-Zero Water Usage Through Rainwater Harvesting at Big-Box Retailers*

Kurt Wurthmann (Nova Southeastern University, USA)

A new modeling approach finds that even under highly favorable conditions, including relatively consistent and high rainfall and no freezing temperatures, use of a rainwater harvesting system (RHS) to meet all water demands for big-box retailers in Broward County, Florida, requires a large cistern and significant costs. Given the relatively low prices for water from public sources in the region, the value of other benefits (including those related to improved reputation and reduced environmental stress) need to be significant to offset the costs and make achieving net-zero water usage through RHS at big-box retailers feasible.

pp. 16-17

10:10 *Analysis of Rainwater Harvesting Methods Considering the Impacts of Climate*

Change

Cris Edward Monjardin, Anne Louie Ente and Gladys Mae Lorenzo (Mapua University, Philippines)

Rainwater harvesting (RWH) has been practiced for a long time but only 4% of the total rainfall amount experienced in the Philippines is utilized. This study then explored on the impacts of climate change and the forecasted rainfall it could generate in a span of 30 years from 2020 - 2050. A local climate model was developed to forecast the annual rainfall for the next 30 years utilizing Representative Concentration Pathway Scenarios 2.6, 4.5, and 8.5. Extracting the minimum and maximum annual rainfall from the projected rainfall, the estimated net runoff was determined which is the study's sole parameter along with a limited catchment area of 40 - 100 m2 in analyzing a RWH method in Barangay San Jose, Antipolo, Rizal. A range of estimated net runoff through the critical scenario of RCP 8.5 was known to be between 60.042 m3 - 234.409 m3 that could be harvested annually. The study has gathered the most common materials and usual capacities of the set collection devices (i.e. rain barrels/drums, tanks and cisterns) and their possible placements available and manufactured in the Philippines. Through the minimum net runoff, a 55-gallon Polyethylene (P.E) rain barrel/drum is suggested and at most, a 12,000-liter P.E/Stainless tank is suggested for the maximum net runoff. The study recommends that parameters like water demand, economy and reliability factors be taken into consideration for better analysis of appropriate RWH methods to be applied in a specific study area

pp. 18-24

PS2: Sustainability Management I

Room B

Chair: Edward G Perkins (Self-employed, USA)

9:10 *The Impact of Strategic Corporate Social Responsibility (SCSR) on Employees' Perceived Job Security and Resilience in SMEs: The Moderating Role of Humble Leadership*

Stavroula Mavrommatidou and Georgios Theriou (International Hellenic University, Greece); Dimitrios Chatzoudes (Democritus University of Thrace, Greece)

Strategic Corporate Social Responsibility (SCSR) constitutes a basic approach that incorporates holistically Corporate Social Responsibility (CSR) within a firm's core operations and allows high performance in combination to social value for long term. Although CSR's strategic role is well acknowledged, there seems to be very limited understanding on the effects of SCSR on employees' attitudes. To fill this gap the present paper tries to figure out the relationship between Strategic CSR and employees' perceived work security and resilience. It also elaborates the moderating role of humble leadership on the above-mentioned relationship and proposes a new model that needs further exploration and research. In this way organizations could realize the impact of SCSR implementation and appropriate leadership on employee' attitudes, and adopt relative practices in the core processes of their business.

pp. 25-30

9:30 *Aerial Drone Use for Sustainable Development in India - A Content Blog*

Analysis

Isaac Lukambagire (Amrita Vishwa Vidyapeetham - Amrita University & Amrita Multi Model Applications and Computer Human Interaction Labs, India); Rao Bhavani (Amrita University, India); Johanna Sophie von Lieres (Amrita Vishwa Vidyapeetham, India)

India urgently requires technological sustainable solutions to resolve its pressing sustainability issues. The study scrutinizes published blog content to explore the use of drones to promote United Nations sustainable development goals in India. Various blog entries were generated through the Google search engine, and screened to retrieve 35 blogs, which exhibited sustainable drone applications and drone operation policies in India. Blogs were published from June 2016 to June 2021 and analyzed through qualitative content analysis using a phenomenological approach. The study identified 4 themes and 10 sub-themes in relation to drone use for sustainable purposes in India. Themes include drone applications for sustainable management of natural resources, drone use for sustainable agriculture, drone implementation for other sustainable purposes in India, such as biodiversity conservation, and drone rules and regulations that enhance sustainability. The study recommends the need to commercialize India's drone industry to promote research on finding solutions to sustainability issues in various sectors.

pp. 31-38

9:50 ***Risk Index Spatial Clustering (RISC): Identifying High Risk Counties Using Local Moran's I and Spatial Statistics for Natural Disaster Risk Management***

Suraj Sheth (University of Chicago, USA)

Building sustainable communities requires the assessment and management of risk from natural disasters. This mitigation of risk must be incorporated across administrative scales, from the national level to the state and county level. Recent data released by the US Federal Emergency Management Agency allows for the identification of risk from natural hazards. For policymakers to take action, they must understand the spatial distribution of risk, identifying spatial patterns of high- and low-risk clusters, as well as outliers. Using Moran's I, I present a novel spatial analysis of a recently published FEMA Risk Index Database in order to identify high-risk communities in need of remedial action to mitigate economic and population losses to natural disasters in the future.

pp. 39-43

10:10 ***An Innovative Enhanced Construction Planning Technique: Analytic & Collaborative Approach***

Qais Amarkhil (Purdue University West Lafayette, USA); Emad Elwakil and Bryan Hubbard (Purdue University, USA)

This paper presents an innovative enhanced planning technique and method. The proposed method consists of three phases: Master, Measured, and Production. This technique proactively assesses the inherent delay risk on a work schedule. To select the most suitable alternate option, it calculates the project schedule's time, location, and inherent criticalities indices. This method also can benchmark the project schedule's criticality and productivity internally within the phases of a project and externally between projects. Thus, the proposed technique helps improve productivity and mitigate delay risk

through the project team's collaboration and assessing inherent delay risk. In addition, enhanced planning is integrable with other scheduling techniques to improve productivity and timely complete work. Applying this technique reduces wastes by streamlining work and decreasing unnecessary inventory on-site.

pp. 44-49

Thursday, April 21 10:40 - 12:00 (America/Los_Angeles)

PNL1: Panel: Accelerating Renewable Energy through Standards

Room: Ballroom

Chair: Sharan Kalwani (Oakland University, USA)

Moderator: Rudi Schubert, Director, IEEE New Initiatives

This presentation will discuss recently released standards enabling renewable energy, and engagements related to these standards where IEEE is actively supporting clean energy and climate change solutions, including our involvement in the Global Power Systems Transformation Consortium.

Panelists:
Mark Siira: IEEE P2030 Working Group Chair, IEEE Standards Coordinating Committee 21 Chair, IEEE SA Standards Board - Standards Review Committee (RevCom) and Audit Committee (AudCom)
Karin Wadsack: Program Manager, National Renewable Energy Laboratory

Thursday, April 21 12:00 - 12:20 (America/Los_Angeles)

LB1: Lunch Break

Room: Ballroom

Thursday, April 21 12:20 - 13:20 (America/Los_Angeles)

K2: How engineers will save the world

Ross Koningstein and David Fork, Google

Room: Ballroom

Chair: Charlie Jackson (IEEE, USA)

The International Panel on Climate Change reported that to remain within a 1.5 °C warming limit, net greenhouse gas emissions need to be reduced to zero by 2050. Doing so by 2050 with carbon-free energy, energy use changes and carbon sequestration presents a host of challenges.

In our 2021 article in IEEE Spectrum we outlined many of the engineering tasks that can keep us busy in the coming decades. The rate and extent to which global net emissions decline depends both on which solutions get developed and deployed and also on filling significant research gaps in order to

realize a full climate solution.

In this talk we will share insights about where we are with respect to some of these challenges and identify where innovations are needed in science, engineering and policy.

Thursday, April 21 13:30 - 14:50 (America/Los_Angeles)

PS3: Intelligent Transportation Systems

Room A

Chair: Charlie Jackson (IEEE, USA)

13:30 ***Architecture of an Innovative Route Planning System for Sustainable Commercial Vehicle Fleets***

Florian Anghelache (University Politehnica of Bucharest & iSYS Professional SRL, Romania); Alexandru Mitrea (University Politehnica of Bucharest, Romania); Nicolae Goga (University of Groningen, The Netherlands); Andrei Vasilateanu (Politehnica University of Bucharest, Romania); Vladut Radulescu and Dan Musat (iSYS Professional, Romania); Diana Scurtu (University Politehnica of Bucharest, Romania)

Nowadays the main challenges for transportation industry are to reduce labor costs, planning time and carbon footprint. Most of the conventional vehicles release considerable volumes of pollutants which accentuate global warming. In this paper we will write about the system architecture of iRoute, an innovative route planning solution specialized for commercial vehicle fleets, considering also electrical vehicles with specific constraints about their drive autonomy and charging stations along the optimized route. We will also describe use cases of such a solution and then detail the main components: Vehicle Data Module, Integration Module, Database, Processing services, User Profile, Optimization Engine, Route monitor services, Driver feedback, Web Application and Mobile Application.

This paper is based on the work on Eureka project PN-III-P3-3.5-EUK-2019-0210.

pp. 50-56

13:50 ***Exploratory Data Analysis of Electric Tricycle as Sustainable Public Transport Mode in General Santos City Using Logistic Regression***

Geoffrey L Cueto (Mapua University & MES Construction, Philippines); Francis Aldrine Uy (Mapua Institute of Technology, Philippines); Keith Anshilo Diaz and Cris Edward Monjardin (Mapua University, Philippines)

General Santos City, as the tuna capital of the Philippines, relies with the presence of tricycles in moving people and goods. Considered as a highly-urbanized city, General Santos City serves as vital link of the entire SOCKSARGEN region's economic activities. With the current thrust of the city in providing a sustainable transport service, several options were identified to adopt in the entire city, that includes cleaner and better transport mode. Electric tricycle is an after sought alternative that offers better choice in terms of identified factors of sustainable transport: reliability, safety, comfort, environment, affordability, and facility. A literature review was conducted to provide a comparison of cost and emission between

a motorized tricycle and an e-tricycle. The study identified the existing tricycle industry of the city and reviewed the modal share with the city's travel pattern. Actual roadside and onboard survey were conducted both to passengers and drivers from the identified terminal to their destination. The survey revealed a number of hazards were with the current motorized tricycle that needs to address for the welfare of the passengers and drivers. With the application of exploratory data analysis using Python program, the study favors the shift to adopting E-tricycle. The model derived from binary logistics regression provided a 72.72% model accuracy. Based from the results and findings, electric tricycle can be an alternative mode of public transport in the city that highly support sustainable option that provides local populace to improve their quality of life through mobility and economic activity. Further recommendation to local policy makers in the transport sector of the city include the clustering of barangays for better traffic management and franchise regulation, the inclusion of transport-related infrastructure related to tricycle service with their investment planning and programming, the roll out and implementation of tricycle code of the city, and the piloting activity of introducing e-tricycle in the city.

pp. 57-64

14:10 *System Design and PV Sizing of a Micro Solar Electric Vehicle for Pakistan*

Ali Husnain and Mohammad Tariq Iqbal (Memorial University of Newfoundland, Canada)

Transport sector is the third-largest contributor to GHG emissions globally. To counter this, global EV adoption has been increasing at a rapid rate. However, Pakistan has been left far behind in this race and is very slow to EV adoption, due to a number of factors including energy shortfall, lack of purchase power, and absence of charging infrastructure to name a few. Therefore, a design for a simple yet economical micro solar electric vehicle has been proposed. This paper covers the sizing and system design for the solar PV system for a solar electric vehicle on HOMER Pro. It also gives an economic analysis of all the components involved.

pp. 65-70

14:30 *Efficient Utilization of MEMS Accelerometers Embedded in Smart Mobile Devices for Intelligent Transportation Systems Applications*

Murat Bakirci (Tarsus University, Turkey)

MEMS technology is of great importance for many research areas such as aerospace, nanotechnology and intelligent transportation systems (ITS). With the rapid development of this technology, especially MEMS microsensors have now become a part of our daily lives. Current work on ITS and intelligent

vehicle systems (IVS) has focused on analysis platforms for unmanned control. Sensing modality is a key parameter of critical importance for these studies. For example, a MEMS accelerometer can be made useful for a wide variety of ITS and IVS applications such as vehicle dynamics control. As smart mobile device technology continues to advance, these devices are becoming a primary part of many research applications because of the advantages they provide. An accelerometer embedded in a smart mobile device can provide continuous dynamic motion data critical to many transportation applications. However, the precision and accuracy of accelerometers are significantly affected by noise, bias, and other internal and external fault behaviors. In this study, it was investigated to what extent an accelerometer embedded in a smart mobile device could improve ITS applications. To improve the accuracy of dynamic motion data, the most common errors, noise and bias, were detected and removed from the raw sensor data. Moreover, the ratiometric error was also investigated, taking into account the long-term data collection process, which is often encountered in ITS applications. In conclusion, the accelerometer's reliability has been confirmed by performance tests using an autonomous unmanned vehicle.

N/A

PS4: Renewable/Alternative Energy

Room B

Chair: Sheraz Anwar (Xiamen University, China)

13:30 *Resilience Metrics for Building-Level Electrical Distribution Systems with Energy Storage*

Spencer Hutchinson, Willy G Bernal Heredia and Omkar A Ghatpande (National Renewable Energy Laboratory, USA)

The energy system infrastructure that delivers power to a building's loads needs to be resilient to withstand and recover from extreme outages (e.g., grid faults that leave millions of people without power during severe weather events). Building-level electrical distribution systems (BEDSs) distribute power from a building's energy sources---including the grid, solar photovoltaic (PV) panels, and batteries---to its loads, including lighting, HVAC, and plug loads. BEDS with storage can provide resilience by distributing local electricity supply to critical loads during an outage. Quantitative metrics are needed to assess the resilience improvements associated with new BEDS and storage system technologies. In this paper, we apply an existing metric, the probability of outage survival curve (POSC), to BEDS with storage and propose novel metrics that improve upon POSC. Through a simulation-based case study, we demonstrate how these metrics are impacted by the BEDS design and how they can be used to design a resilient system.

pp. 71-78

13:50 *Forecast Error Modeling for Microgrid Operation Considering Correlation Among Distributed Generators Using Gaussian Process Regression*

Yeuntae Yoo and Seokheon Cho (University of California, San Diego & Qualcomm Institute, USA); Sung-Geun Song (Korea Electronics Technology Institute, Korea (South)); Ramesh R. Rao (UCSD, USA)

The small-scale and self-sustainable grid, as known as micro-grid(MG) is a key element for future power systems with high penetration of renewable generators. The uncertainty of renewable power generation

such as Photovoltaic(PV) and wind turbine, needs to be compensated with balancing devices that are often referred to as reserves of the power system. The reserves can be an Energy Storage System(ESS) or conventional fossil-fueled thermal generators with enhanced flexibility. The uncertainty of renewable generators can be statistically analyzed for cost-effective assessment and operation of those compensating devices. Multiple uncertainty factors are investigated and modeled as a joint probability distribution function(PDF) considering the temporal correlation between them. Several uncertainty factors with different marginal distributions and scales are integrated as multivariate probability distribution by transforming them into normal distribution using rank correlation. As the number of uncertainty factors increases, the conditional probability distribution generated from joint PDF loses its accuracy. In this paper, a method to model the distribution of net-load forecast error is proposed considering the correlation among uncertainty factors. A data-driven Gaussian process regression is introduced to train and validate conditional PDF among uncertainty factors, which are transformed into normal distribution without losing intrinsic marginal distribution.

pp. 79-85

14:10 *Optimization of a Micro Hydro Power Plant*

Somila Hashunao (NERIST, Deemed University, Nirjuli, Itanagar, India)

The life style of well-being are define by consumption of electric load. Electricity play major setback both on economic as well as social well-being. Micro Hydro Power as cost effective and eco-friendly, is a magnolious tactic in deploying local natural sources for power such as from small scale rivers and streams. The turbine can run with or without the reservoir, usually fetch from run-off-river type. The flowing water strike directly into the turbine and then water flow down the stream without effecting the cycle of the system which in return gave minimal impact to the environment and maximum benefit to the surrounding where grid connectivity might not be recommendable due to its various cons. In many isolated remote area with few population grid connected has a major drawback on cost. So exploring more on locally available renewable resource will bring a wider prospect in terms of economical as well as maximum beneficial. In order to recapitulate the optimization hurdle of Micro Hydro Power plant a python programming has been done with a single objective function taken into account valuation of the plant as the fitness function (minimization problem).

N/A

14:30 *An Exploration of Un-Electrified Remote Area Community Life*

Somila Hashunao (NERIST, Deemed University, Nirjuli, Itanagar, India)

Life of being is difficult without the connection of electricity. Load demand indicate the status or standard of that particular zone/region. It's a parameter which indicate the standard of living. Arunachal Pradesh has bestowed abundantly with natural renewable resources which are eco-friendly and pollution free especially in rural areas where energy demand is still unreached. This paper focus on the available resource which has potential for small scale energy generation so as to reach out the electrical demand of rural communities which are economical backward with low standard of living and scattered population. During the site survey, field observation, interaction with the local people and various information were collected in order to map for a viable off-grid technology. The paper also discusses about barrier to the people along with the consequence and prospect that can be embedded from the available in sustainable energy technology and concluded that with less population and far away from the grid connected system it will be more wise and economical to focus on small scale renewable energy with the available natural resources.

N/A

Thursday, April 21 15:00 - 16:00 (America/Los_Angeles)

K3: Engineering in a Responsible World

Jen M. Huffstetler, VP and GM, Data Center Platform Strategy, Mobilization, Sustainability and Services, Intel

Room: Ballroom

Chair: Md. Fahim Chowdhury (Auburn University, USA)

What is sustainability worth to the next generations? What expectations do we set for ourselves to ensure a more sustainable tomorrow? Intel has established a long-standing commitment to environmental leadership to achieve efficiency, reduce costs, and respond to the needs of our customers and community stakeholders. In this talk, we'll challenge engineers to rethink and reimagine technologies and businesses with sustainability in mind. This will require disruptive solutions that are outside the norm and non-traditional, such as data centers that reuse heat and platforms that are carbon aware. We are solving big problems to help protect our planet and improve the lives of every person. Join us on the journey.

Thursday, April 21 16:10 - 17:30 (America/Los_Angeles)

PS5: Smart Cities

Room A

Chair: Sean Monemi (California State Polytechnic University at Pomona, USA)

16:10 ***Incentivizing Distributed Energy Resource Participation in Grid Services***

Tylor E Slay (Portland State University & MASEEH College of Engineering and Computer Science, USA); Robert Bass and John M Acken (Portland State University, USA)

The bulk power system is experiencing a dramatic shift as renewable generation growth continues to accelerate. Large-scale renewables adoption will help societies transition to a low-carbon, low-cost, and environmental-friendly electrical power system. However, the transition from a paradigm of generation following load to one where load follows generation will require large-scale interconnection and coordinated operation of Distributed Energy Resources (DERs), supported by open communication protocols. In this future grid scenario, DER aggregations will provide critical grid services that enable high penetration levels of renewable generation. This position paper presents an Energy Service Interface (ESI) that defines scope for ensuring secure, trustworthy information exchange between grid service providers and DERs. The goal of the ESI is to encourage large-scale participation of DERs in order to provide grid services through dispatch of DER aggregations. This position paper also presents an open smart energy communications protocol that allows DERs to advertise their characteristics and participate in grid services, within constraints established by the ESI. The paper presents several monetization incentives that grid service providers could use to encourage large-scale DER participation.

pp. 86-91

16:30 *Protection Relays in a Model of IEEE n-Bus System Using Real Time Digital Simulation*

Sean Monemi (California State Polytechnic University at Pomona, USA)

This paper presents how to design and implement a set of protection relays in a prototype model of an IEEE n-Bus system using Real Time Digital Simulation (RTDS). A power system is constructed using RSCAD tool, a software designed to run on RTDS machine. Protection schemes are also implemented on RSCAD, in addition current and potential transformer components are placed in areas of interest on the prototype model. The signals are outputted from the RTDS Gigabit-Transceiver Analogue Output card (GTAO) then sent to the Schweitzer SEL-311L relay, which allows various protection schemes to be realized. A test and validation are designed for this model of power grid utilizing RTDS, a simulator that transmits analogue voltage and current to the designed power system in real time.

Presenter bio: Dr. Sean Monemi is currently a Professor and the Director of Center for Smart Grid in Electrical and Computer Engineering at California State Polytechnic University (Cal Poly Pomona). He is teaching a broad range of Undergraduate and Graduate level courses in electrical and computer engineering. His research areas are: Smart Grid, Power, Energy, Renewable, , Algorithms and Complex Computations, Energy Management, Operating Systems, and Software Engineering. Previously, Dr. Monemi served as the Associate Research Professor and Research Scientist at Vanderbilt University, where he conducted research in the areas of Model Integrated Computing, Diagnostics, and Fault Management Analysis in Power Grid.

pp. 92-99

16:50 *A Complete State Transition-Based Traffic Signal Control Using Deep Reinforcement Learning*

Guoyuan Wu (University of California, Riverside, USA); Shangrui Liu (University of California at Riverside, USA); Matthew J Barth (University of California, Riverside, USA)

Traffic signal control is a fundamental but challenging real-world problem that manages traffic at roadway intersections by adjusting signal timing and phases sequences. With the advances in emerging transportation technologies (e.g., Connected and Automated Vehicles, roadside sensing, drones), richer information (e.g., vehicle position, speed, type) has now become available in real-time, which can be utilized to reduce congestion. This paper introduces a deep reinforcement learning (DRL)-based traffic signal control (TSC) method for isolated intersections, where vehicles' positions and speeds (available via V2I, roadside sensing, or drone-based surveillance) are processed by a convolution neural network (CNN) and fed into the RL system as inputs. In addition, a complete state transition process using a dual-ring mechanism is introduced to enable flexible traffic signal control. Using a traffic simulator (SUMO: Simulation of Urban Mobility), the proposed algorithm is compared with both fixed-time and actuated TSC under different traffic conditions. Results show that the DRL-based strategy can reduce average delay and

pollutant emissions by 34.7% and 18.5%, respectively.

pp. 100-107

PS6: Smart Grid

Room B

Chair: Yan Wang (Temple University, USA)

16:10 ***A Means for Tuning Primary Frequency Event Detection Algorithms***

Sean Keene, Landon Hanks and Robert Bass (Portland State University, USA)

Power system balancing authorities are routinely affected by sudden frequency fluctuations. These frequency events can precipitate cascading outages and cause damage to both customer-owned and utility equipment. In this document, we describe an algorithm evaluation environment that uses a suite of metrics to evaluate an algorithm and quantify its efficacy. Using the algorithm evaluation environment, a detection algorithm can be tuned to best match the definition of a frequency event as defined by experts within the context of their own balancing area. We demonstrate the utility of the algorithm evaluation environment using a regression-based frequency event detection algorithm. This algorithm is capable of detecting frequency events within a short period of time after the onset of an event. The algorithm has four parameters that can be adjusted, making it highly tunable and therefore suitable for demonstration of the algorithm evaluation environment.

pp. 108-113

16:30 ***Study of Cascading Failure Duration in Power Grid Using Historical Outage Data and Simulation Model***

Saikat Das and Zhifang Wang (Virginia Commonwealth University, USA)

Cascading failures in an interconnected system like a power grid can result in a large number of line outages and blackouts. In this paper, we have studied the duration of cascading failures using historical utility outage data. We have estimated the distribution of cascading failure duration and determined the average duration of a cascading failure process. We have incorporated a cascading failure simulation model with ac power flow to compare our empirical results with the simulated result using two 500 bus synthetic grid test cases, one of which has been generated using a Matlab-based toolkit to make the comparison realistic. We have also analyzed the effect of different loading levels on cascading failure duration. The results were in good agreement for both cases which validate the distribution of cascading failure duration and also the simulation model.

pp. 114-119

16:50 ***Shared Trench for Burying Cables in the Conversion of Overhead to Underground Networks***

Maileen S Simão, Euler Ribeiro, Beatriz B Cardoso and Marcos Aurelio Izumida Martins (CERTI Foundation, Brazil); Moacir F Lopes, Jr. and Fabricio Rodrigues (Enel Distribuição São Paulo, Brazil)

Presented as a strong trend around the world, the burial of electricity networks aims to mitigate conflicts with the physical environment, generating positive aspects in the use of public space, in the aesthetics of the urban environment, in addition to contributing to the safety of citizens. Such action is already implemented in several countries, having as standard the installation of low voltage cables on sidewalks and medium voltage cables on roadways. However, due to the high number of interferences and the high maintenance and operation costs, as well as the possible negative impacts on the environment and traffic, it is not always feasible to use this process, especially in large urban centers. Thus, this article brings to light the study of a new method of allocation of pipelines for underground electricity distribution grids, based on the premise of sharing trenches between low and medium voltage grids, presenting the innovative constructive methods involved and the direct benefits to society and the environment. This study is part of an R&D project proposed by ENEL Distribuição São Paulo, called "Urban Futurability", which, together with other work fronts, develops a new concept of a pipeline bank.

pp. 120-124

17:10 ***Deferrable Irrigation Load Optimization in Rural Microgrid Clusters***

Rohitaa Ravikumar (SSN College of Engineering, India); Manasvini Venkatraman Srinivasan (College of Engineering, Guindy, India); Raj Vignesh Karunakaran and Adittya Srikanth (SSN College of Engineering, India); Vineeth Vijayaraghavan (Solarillion Foundation, India)

The paper proposes a design optimization strategy for improving irrigation load servicing in existing standalone rural microgrids in the Indian village Dharnai. The Deferrable Load Servicing Grid (DLSG) consists of Clustered Microgrid Architecture (CMA), where irrigation and domestic standalone microgrid entities are integrated. The Deferrable Load Servicing Algorithm (DLSA) treats the irrigation load as a deferrable load to utilize excess energy effectively. The model is further designed to satisfy the socio-economic conditions of the village by proposing two optimized systems, namely, Efficiency Optimized System (EOS) and Cost Optimized System (COS). The EOS and COS designs optimize efficiency and lifetime costs, respectively. Comparing both designs to the currently operating CMA, the EOS provides an efficiency gain of 6.35% while maintaining the lifetime cost. In contrast, COS provides an 18% relative decrease in total lifetime cost while preserving the irrigation and domestic efficiency.

pp. 125-131

Thursday, April 21 17:40 - 17:55 (America/Los_Angeles)

WUP1: Day 1 Wrap-up

Room: Ballroom

Chair: Sharan Kalwani (Oakland University, USA)

Thursday, April 21 18:00 - 21:00 (America/Los_Angeles)

STPC: Student Poster Competition

Room: Ballroom

Chair: Sean Monemi (California State Polytechnic University at Pomona, USA)

Thursday, April 21 18:00 - 19:00 (America/Los_Angeles)

SPC1: SPATIAL CHAT

Room: Spatial Chat

Friday, April 22

Friday, April 22 8:00 - 9:00 (America/Los_Angeles)

OPK2: **Opening Remarks & K4: Leveraging data to drive Sustainability in the Energy sector**

Keynote: Leveraging data to drive Sustainability in the Energy sector
Jayant Sinha, Senior Principal Consultant, Utilities India Industry Platform, Capgemini

Room: Ballroom

Chairs: David Gonzalez (IEEE, USA), Shafkat Islam (Purdue University, USA)

As the countries around the globe race to meet their net zero deadlines, data plays an important role in analyzing climate change impacts in the energy sector. Also, technology plays a crucial role in mapping the humongous data residing in various forms, at diverse locations, to corresponding energy and carbon performance. In this keynote, I will talk on the role of digital technologies such as machine learning (ML), robotic process automation (RPA) and intelligent instrumentation, in real-time assessment, data visualization, smart analytics and generating insights for predicting potential carbon footprint of various energy practices. These data insights help the energy and utility sector to take decisive actions proactively to mitigate climate change repercussions, reduce emissions and promote sustainability.

Friday, April 22 9:10 - 10:30 (America/Los_Angeles)

PS7: Water Resources Management

Room A

Chair: Edward G Perkins (Self-employed, USA)

9:10 *Development of Racking and Irrigation System for Industrial Revolution 4.0 Vertical Farming*

Vijayapragas Muniandy, Ir (Tunku Abdul Rahman University College, Malaysia)

This paper presents a design for multi-layer vertical farming rack to be used as an integrated component in fully automated farming of ginger plants with minimum interactions of humans, in line with Industrial revolution 4.0. The vertical rack is designed in parallel so an Automated Guided Vehicle (AGV) can travel along in the middle for data collecting, observation and retrieving purposes. The whole rack system can

hold 96 plants, consists of two 19 m rows. Each row has two stacks of plants. 64 units of plants will receive LED treatment, where else the balance 32 unit of plants will not have LED installed for experiment purposes. Rack will be equipped with protrusions to assist robot with its position sensor. Also, each plant containment will be equipped with required LED lights and watering system, complete with waste water drainage path. AGV was tested along the racks to test its stability and reachability of the arm in retrieving plants tray. This test was carried out using dummy load to test the overall strength, vibration and accuracy of the AGV arm. All tests passed satisfactory.

Presenter bio: The author graduated in Universiti Teknologi Malaysia (UTM) in year 2012 with Bachelor of Engineering (Hons) Mechanical (Automotive) Engineering. Continued study to Ph.D. level in Mechanical Engineering, focusing research on vehicle dynamics field. Obtained Ph.D. from UTM in 2016 and currently working as senior lecturer in Tunku Abdul Rahman University College. Obtained his professional engineer certificate from Board of Engineers Malaysia in 2018, which helps to participate actively in multiple researches in TAR UC as main and co-researcher, mainly related to Industry Revolution 4.0.

pp. 132-135

9:30 *A Non-Linear Differentiable Model for Stormwater-Based Irrigation of a Green Roof in Toronto*

Chia-Hui Yeh and Margaret Chapman (University of Toronto, Canada)

Green infrastructure has potential to alleviate the environmental impact of rapidly growing cities. This potential has inspired laws in Toronto that require the inclusion of rooftops with large vegetation beds, called green roofs, into sufficiently sized construction projects. We study the problem of reusing stormwater to irrigate a green roof in Toronto, where potable water is the current irrigation source. The vision is that widespread reuse of stormwater runoff for irrigation of green roofs and other purposes can reduce sewer overflow volumes without over-building (with the added benefit of conserving potable water). Towards this vision, our goal is to develop and evaluate two pump controllers for transporting stormwater to the green roof of interest in simulation. A key contribution is our development of a site-specific non-linear model for stormwater flow using smoothing techniques that permits linearization and a standard model predictive controller (MPC). We compare the efficacy of the MPC, which anticipates the weather, and an on/off controller, which is reactive rather than anticipative, for the site in simulation. With further study, we are hopeful that this research will advance control systems technology to improve the performance of green and stormwater infrastructure in growing urban areas.

pp. 136-143

9:50 *A Sustainable Integrated Rural Water Management with Emphasis on Network Prioritization, Household Water Treatment and Real-Time Feedback*

Raghavendra Kumar Raya, Soumya Kar and Dhanesh Kumar (Birla Institute of Technology and Science, Pilani, India); Rajiv Gupta (BITS Pilani, India)

Rural water infrastructure management, an essential aspect of sustainable living in rural areas, is an ignored subject compared to urban areas. For instance, multiple urban studies, such as integrated urban water management (IUWM) and water sensitive urban design (WSUD), discuss the structured management of water, land, and resources for acquiring the most lucrative and societal benefits. However, many rural water infrastructures lack proper planning, coordination, and monitoring. Besides, minimal applied decision making at lower levels misleads to the inefficiency of rural water sources. Research gaps exist in long term

water quality testing and continuous monitoring of stored water in rural areas. The current study aims to develop a decentralized system, termed Sustainable Integrated Rural Water Management (SIRWM), for overcoming the challenges plaguing rural areas by utilizing rainwater harvesting (RWH) as the primary source in a study area in Rajasthan, India. The overall setup of the SIRWM targets to diminish over-reliance on groundwater sources in areas facing drought. The study comprises five segments, in the sequential order of survey and data collection, network prioritization, implementation of RWH system using Building Information Modelling (BIM) tools, installation of water filters at households, and collection of real-time feedback through interactive voice response system (IVRS) (an android application) in a selected community of the study area. The integration of all these components results in achieving a robust rural water management.

pp. 144-149

10:10 ***Deterioration Modeling and Failure Analysis of Water Distribution Networks***

Thikra Dawood and Emad Elwakil (Purdue University, USA); Hector Mayol Novoa and José Fernando Gárate Delgado (National University of St Augustin of Arequipa, USA)

This paper presents a novel framework for the deterioration modeling in conjunction with quantifying the water network's failure index. It involves developing a method and an intelligent model using Monte Carlo Simulation to estimate the deterioration indices (DIs) of watermains through intricate iterative simulations. The developed method is implemented on the water system of the City of El Pedregal in Peru. The efficacy of this framework has been verified against the multiple linear regression (MLR) method and proved to be sound. The developed framework provides insights for infrastructure managers in the aspects of, when to intervene, what to maintain, replace, or rehabilitate.

pp. 150-153

SSSA: Special Session: Powering Sustainable Aviation

Room B

Chair: Siobhan M Dolan Clancy (& SDC Business Consulting Ltd., Ireland)

9:10 ***Cross-Fertilization of Space and Aviation Towards Electrical Systems***

Jean-François Lumens (Belgium)

In the past decade, the space and aviation sector have moved closer to one another. While space launchers may sometime be source of inspiration or demonstrators for future generations of aeronautical equipment, competitiveness lessons from the aircraft equipment market are also increasingly considered in the space sector. This is clearly observed through the customer requests received by Sabca, working at the cross road of space and aviation sectors. Thanks to technological progress enabling improved reliability, lower weight and cost, the shift to more electrical system has long been started for recently developed space launchers. New low cost, reusable launchers are mostly focusing on electrical equipment. The more electrical aircraft, enhanced by the public incentive for low-carbon emission aviation is now following such trend, expecting benefit from technical progresses of fully electrical systems. On the other hand, the demand for low cost reusable launcher is now seeking inspiration from the more competitive aircraft sector to significantly reduce the cost-per-kg of in-orbit payload.

Presenter bio: Mechnical engineering degree Post-graduate degree in Management Sciences
N/A

9:40 *Airplane-Quadcopter UAV Hybrid Incorporating Power Regeneration Technologies & Weight Minimization*

Martin O'Connell, Raven Santos, Brianna Ho, Isaac Hasan, Joshua Kidwell, Lizbeth Gamino, Christian Corral, Diego Portillo-Gonzalez, Luis Ortiz Echeverria, Francesco Ruotolo and Ivan Sanchez (California State Polytechnic University, Pomona, USA); Steven Dobbs (California State Polytechnic University at Pomona, USA); Jesus Rojas, Andrea Dominguez, Derek Mata, Dominic Sanqui and Mumen Abbas (California State Polytechnic University, Pomona, USA); Christian A Ruvalcaba (California State Polytechnic University, Pomona & Pacific Transformer, USA); Hanqing Zhao, Dylan Godfrey, Michael Youssef, Alan Viernes, Christopher Hua, Steven Huynh, Peter Ayad, Christopher Watson, Anthony Damelio and Reynaldo Martinez Villalobos (California State Polytechnic University, Pomona, USA); Zhen Yu (California State Polytechnic University at Pomona, USA)

This paper encompasses the developments by a California State Polytechnic University, Pomona student engineering team to increase the endurance and range of an airplane-quadcopter unmanned aerial vehicle (UAV) hybrid via in-flight power regeneration and structural battery integration. Electric UAVs are commonly limited by low range and flight endurance, limiting the capabilities of an operator and affecting their mission. Increasing these parameters would allow a UAV to operate for extended periods of time in surveillance and inspection capacities in both civilian and military capacities. Additionally, by combining the flight characteristics of a conventional fixed-wing aircraft with the hovering capability of a quadcopter, a UAV can become vertical takeoff and landing (VTOL) capable and can maneuver over points of interest more precisely. An off-the-shelf quadcopter and airplane are to be extensively modified by the team to create the hybrid craft, with structural batteries replacing conventional wing spars, solar cells replacing the upper wing skins, and wireless induction coils replacing the lower wing skins. A power management system will be used to efficiently control battery usage and balance generated power with expended power. A ground station will also be built to remotely swap drained batteries with fresh replacements, with the aircraft automatically returning to recharge, then launching again to resume autonomous flight.

pp. 154-160

10:00 *Hybrid Power Drive Solution for Increased Sustainability in Aircraft Actuation Systems*

Shane O'Donnell (University of Nottingham, Ireland & Microchip, Ireland); Laurence Egan (Microchip Technology, Ireland); Alan Calmels (Microchip Technology, France); Patrick Wheeler (University of Nottingham, United Kingdom (Great Britain))

As aircraft become more electric, power electronic solutions are increasing in importance. Hydraulic and pneumatic systems are being replaced with more sustainable electronic alternatives which offer significant advantages including lower weight, less maintenance and increased reliability. Furthermore, gains can be achieved in operational efficiencies as electrical systems offer more options for re-configurability and solutions can be developed for use within various aircraft functions. This paper presents a Hybrid

Power Drive integrated power module for increased sustainability in aircraft systems. Developed by Microchip, it primarily drives various electrical motors, and yet, can be customized to meet specific customer requirements. This flexible solution can accommodate a wide range of commercial aviation actuation systems. The necessity for fully custom products is therefore reduced, providing a more sustainable solution for the next generation of aircraft.

Presenter bio: Shane O'Donnell is the Senior Manager of Systems Engineering for Microchip's Integrated Power Solutions group and also manages the Aerospace Centre of Excellence in Ennis, Ireland. He joined Microchip, then Microsemi, in 2009 as Principal Engineer and in 2011 became the Product Engineering Manager working on the development of the non-hermetic discrete product range. In 2012, he was Product Line Manager for these devices before adopting his current responsibilities in 2013. Prior to Microchip, he spent 13 years working as an electronics design engineer in 3 medical companies, Vitalograph, Respironics and Crospon. Mr. O'Donnell holds a B.Eng. degree in Electronic Engineering from the University of Limerick and is currently undertaking a PhD in Electrical and Electronic Engineering in the University of Nottingham. The area of his research is Wide Bandgap Semiconductors and their use in More Electric Aircraft.

pp. 161-164

Friday, April 22 10:40 - 12:00 (America/Los_Angeles)

PS8: Sustainability Management II

Room A

Chair: Justin Y. Shi (Temple University, USA)

10:40 ***Automated Identification of Used Beverage Cans for Deposit Return Using Deep Learning Methods***

Spencer Ploeger and Matthew E. Bolan (University of Guelph, Canada); Lucas Dasovic (Canada)

Accurate sorting of recyclable materials, especially aluminum, is an important process within municipal Material Recovery Facilities (MRFs) as it has a high scrap value and is easily recycled, keeping it out of landfills. Additionally, in jurisdictions that have deposit return programs, MRF operators may return permitted cans and collect the higher deposit value, thus increasing profits. This interest in accurate sorting creates an ideal environment for computer vision and deep learning applications, specifically, the classification and sorting of cans with higher accuracy than human sorters, which are often central to this process. In this work, a can classification dataset was created following the Ontario, Canada's deposit return program's definitions. The dataset contains images of returnable and non- returnable cans. Neural networks based on Mask R-CNN are then trained to classify can images as returnable or non-returnable. The neural networks achieve excellent results, with over 99% class accuracy on the testing dataset. Lastly, recommendations for future work and recommendations for system installation and integration are discussed.

pp. 165-172

11:00 ***Harnessing the Power of Ocean Waves to Make Electric Energy***

Reza Kamali-Sarvestani (California State University San Marcos, USA); Hamed

Nademi (California State University-San Marcos, USA)

Power electronic converters are an enabling technology for the emerging marine energy applications such as Ocean Waves to produce electricity. This paper outlines the key components comprising the conceptual wave energy converter with modularity and scalability features into consideration to generate power efficiently. The studied wave converter could be deployed for several key functionalities, notably to supply electricity to coastal communities and for producing drinking clean water. The preliminary modeling and simulation results verify the design objectives, and some selected results are discussed in this paper.

pp. 173-176

11:20 *Proposed Application for an Entity Component System in an Energy Services Interface*

Tylor E Slay (Portland State University & MASEEH College of Engineering and Computer Science, USA); Robert Bass and Grace Spitzer (Portland State University, USA)

An Entity Component System is a data-oriented architecture originally developed to streamline video game performance. Despite being quite new, Entity Component Systems are relatively well established within the video game industry due to the cutting edge nature of research into performance, especially around graphics. However, Entity Component Systems have not been widely examined or adopted outside of that industry. We propose adopting an Entity Component Systems framework to serve the needs of an Energy Service Interfaces. We examine the needs of an Energy Service Interface, give an overview of open-source Entity Component Systems (ECSs) libraries, examine some preliminary performance results for ECSs, and explore the traditional approach to fulfilling the needs of an Energy Service Interface (ESI) with database architectures.

pp. 177-180

11:40 *Novel Robotic Approach to Irrigation and Agricultural Land Use Efficiency*

Alexander W Hoppe, Emmanuel Jefferson, Jake Woodruff, Lachlan McManus, Nicodemus Phaklides and Tia McKenzie (Embry-Riddle Aeronautical University, USA)

Current industrial agricultural methods often use inefficient watering, fertilizing, and pest control practices, in part because they lack feedback systems. The prototype proposed combines current agricultural sensing and analysis research with a robotic platform to precisely monitor and care for crops. In this paper, we provide a proof of concept with a path to scalability such that the system may be implemented at an industrial scale.

Presenter bio: Nicodemus Phaklides is a Electrical Engineering senior at Embry-Riddle Aeronautical University in Prescott, Arizona.

pp. 181-186

PS9: Energy Efficiency

Room B

Chair: Charlie Jackson (IEEE, USA)

10:40 *Enhancing the Performance of Multi-Agent Reinforcement Learning for Controlling HVAC Systems*

Daniel Bayer (Friedrich-Alexander-University Erlangen-Nuremberg, Germany); Marco Pruckner (University of Erlangen-Nuremberg, Germany)

Systems for heating, ventilation and air-conditioning (HVAC) of buildings are traditionally controlled by a rule-based approach. In order to reduce the energy consumption and the environmental impact of HVAC systems more advanced control methods such as reinforcement learning are promising. Reinforcement learning (RL) strategies offer a good alternative, as user feedback can be integrated more easily and presence can also be incorporated. Moreover, multi-agent RL approaches scale well and can be generalized. In this paper, we propose a multi-agent RL framework based on existing work that learns reducing on one hand energy consumption by optimizing HVAC control and on the other hand user feedback by occupants about uncomfortable room temperatures. Second, we show how to reduce training time required for proper RL-agent-training by using parameter sharing between the multiple agents and apply different pretraining techniques. Results show that our framework is capable of reducing the energy by around 6% when controlling a complete building or 8% for a single room zone. The occupants complaints are acceptable or even better compared to a rule-based baseline. Additionally, our performance analysis show that the training time can be drastically reduced by using parameter sharing.

pp. 187-194

11:00 *Balanced Model Order Reduction Techniques Applied to Grid-Tied Inverters in a Microgrid*

Md. Rasheduzzaman (Southeast Missouri State University & Missouri S&T, Southeast Missouri State University, USA); Poria Fajri (University of Nevada, Reno, USA); Bamdad Falahati (Leidos Inc., USA)

Multiple model order reduction strategies applied to grid-tied inverters in a microgrid setup are assessed in the proposed work. The full-order mathematical model of a grid-tied inverter is first derived for this purpose. The nonlinear equations of a grid-tied inverter system are derived in the synchronous reference frame and then linearized around an operating point to construct a 15 state small-signal model. The 15th order state full order model is then reduced using balanced truncation, balanced residualization, and balanced stochastic truncation. Each of these model reduction techniques results in a 6th order reduced model. Simulation results obtained using PLECS are used to compare the accuracy and equivalency of the reduced-order models to that of the one found using the full-order model. After comparing the results, the balanced residualization method is found to be the most suitable method for the given system.

Presenter bio: MD. RASHEDUZZAMAN (M'12) received the B.S. degree in electrical and electronic engineering from the Chittagong University of Engineering and Technology, Chittagong, Bangladesh; the M.S. degree in electrical and computer engineering from Purdue University Calumet, Hammond, IN, USA; and the Ph.D. degree in electrical engineering from the Missouri University of Science and Technology, Rolla, MO, USA, in 2006, 2010, and 2015 respectively. He is currently working as an Associate Professor in the Department of Engineering and Technology at Southeast Missouri State University, Cape Girardeau, MO, USA. His research interests include microgrids, power systems, and power electronics.

pp. 195-202

11:20 *Modeling and Optimization of Energy Performance for a Water-Cooled Chiller Plant Deployed in Multi-Story Office Building*

Yesaswini Chilukuri (Indian Institute of Technology Madras (IITM) Research Park, India); Samit Bhowmick and Prashant Dubey (Veratatva Engineering Consultant LLP, India); Adil Usman (University of California Santa Cruz, USA)

This study presents an approach to calibrate energy performance model and optimization in control methods of HVAC to influence the annual energy consumption and operating cost savings. Calibration involves iterative improvements to bring model outputs in line with that of the measured date of an existing building. These models provide a means of understanding building operation as well as optimizing performance. Therefore, the study focuses to provide lessons learned and recommends best practices for effective calibration and optimization of the water-cooled chiller of an office building located in Bangalore, India. The chiller size is of capacity 425TR with annual cooling energy consumption of 260 MWh. After carrying out 30 iterations in the model the resulted CVRMSE is 5% and NMBE of 1% are achieved. This calibrated model is further taken to find the optimized chiller outlet water temperature on the evaporator side. It is found that by an increase in outlet water temperature to 9°C, the energy savings were found to be 1.2%.

pp. 203-208

11:40 *Optimal Seasonal Spinning Reserve Scheduling for Islanded Microgrid Operation Under Contingency Conditions*

Tarek Masaud (University of Colorado Colorado Springs, USA); Mohammed Siddiqui (Marshall University, USA)

The spinning reserve (SR) can be defined as the amount of unused power capacity in an online power generation unit which can compensate for power shortages or frequency deviation within a given period of time. Power shortage is a common issue in microgrid operation. Hence, determining optimal scheduling of SR for microgrid operation under contingency condition is one of the most important aspects of microgrid operation under contingency events. This paper proposes an economic dispatch optimization algorithm to find optimal scheduling of spinning reserves in islanded microgrid operation under both normal and contingency conditions. The seasonal variation of net load is considered in this study. The problem is formulated as a Mixed Integer Linear Programming (MILP) problem and carried out using CPLEX software. Simulation results have shown the effectiveness of the developed algorithm.

Presenter bio: Tarek Masaud, Ph.D Assistant Professor, Department of Electrical and Computer Engineering University of Colorado Colorado Springs 1420 Austin Bluffs Pkwy Colorado Springs, CO 80918 Office: Engineering Complex 231B E-mail: tmasaud@uccs.edu Research Interest - Renewable Energy and Distributed Generation - Induction Generators for Wind Energy Applications - Microgrid design and optimization Education - Ph.D. Colorado School of Mines, 2013 - M.Sc. Colorado School of Mines, 2012 - M.Sc. Academy of High Graduate Studies, Libya 2007 - B.Sc. 7th of April University, Libya 2003

pp. 209-213

Friday, April 22 12:00 - 12:20 (America/Los_Angeles)

LB2: Lunch Break

Room: Ballroom

Friday, April 22 12:20 - 13:20 (America/Los_Angeles)

K5: Climate Risks and Solutions

Paul Werbos

Room: Ballroom

Chair: Edward G Perkins (Self-employed, USA)

From my years running Adaptive and Intelligent Systems and Electric Power Research at NSF (until 2015), I learned that new technologies - some well proven and grounded in work centered in the IEEE Power and Energy Society - would allow us to stop climate destruction much sooner and faster, and at lower cost, than any of the schemes we have heard from policy gatherings like COP26 or legislation anywhere on earth, including even the 2009 Obama climate bill which I evaluated for an office of the US Senate in 2009.

Based on my talks and papers on the risks and solutions (http://www.werbos.com/climate_extinction_risk_and_solutions.htm), the IEEE/Wiley Series Editor for Power and Energy asked me to organize an edited book, by creating new connections and dialogue between all the players who are truly at the scientific and technical front lines of the risk and of the new solutions.

This was an incredible learning experience, bringing out risks, near-term opportunities and optimal tradeoffs no one on earth knew about before these discussions and new networks. This talk will give an overview of the most important highlights, and opportunities for action.

Friday, April 22 13:30 - 14:50 (America/Los_Angeles)

PS10: Social Impact of Technology

Room A

Chairs: Charlie Jackson (IEEE, USA), Jay Pearlman (USA)

13:30 *Social Acceptance of Photovoltaic Solar Technology in Saudi Arabia*

Malek Alduhaymi, Saleh Komies and Abdulaziz Mohammed Alshaya (Imperial College London, United Kingdom (Great Britain))

Saudi Arabia's Vision 2030 includes various pillars in its programs, one of which is to strengthen and diversify its economy. Improving the energy sector in Saudi Arabia by including renewable resources will expand Saudi's energy mix, enhancing its economy. In this paper, a detailed evaluation of the social

aspect of deploying the first large-scale photovoltaics (PV) solar project in the Kingdom of Saudi Arabia is discussed. Furthermore, a survey which contained ten multiple choice questions covering two aspects had been conducted among Saudis to measure the social acceptance of Al-Jouf Solar Project.

pp. 214-218

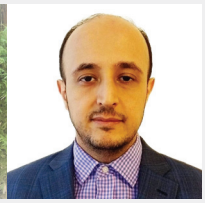
13:50 *Does Immergence of ICT Focused Institutions Increase the Pace of Urban Development? A Provincial Case Study in Iran Using Data from the Ground and Above*

Mohammad Tondro (University of Texas at Arlington, USA); Mohammad Jahanbakht (University of Texas at Arlington, USA & Sharif University of Technology, Iran); Shourav Bin Rabbani (Data and Design Lab, Bangladesh); Moinul Zaber (United Nations University, Portugal & University of dhaka, Bangladesh)

The information and communication technologies (ICT) is considered to be a key vessel for development, with significant impact in urban development in the developing countries. This study presents evidence of the positive catalytic role of the immergence of ICT focused institutions on urban development as proxied by Night-time Lights (NTL) satellite data. We relied on a case study method of Alborz province in Iran and gathered in-depth data timeline attributes of all ICT based enterprises and academic institutions and NTL satellite imagery within this region. We then analyzed the imagery and gathered data to extract patterns and generate trends and suggest the growth inducive trend of ICT focused institutions.

Presenter bio: Mohammad Tondro is a PhD candidate in Management of Technology at Allameh Tabataba'i University (ATU) in Iran. Also, he is visiting researcher at the University of Texas at Arlington in Dallas, USA. Mr. Tondro holds a Bachelor of Science degree in Electrical & Communication Engineering in 2007 and a Master of Business Administration (MBA) in 2012 from Multimedia University, Malaysia. He is a Researcher Fellow in Management of Technology and innovation process at the university. His research interests include Management of Technology, Industry 4.0 technologies adoption in organizations and emerging societies.

Presenter bio: Assistant Professor in Engineering (and Technology) Management in Department of Industrial, Manufacturing, and Systems Engineering at The University of Texas at Arlington. I am interested in areas of technology and innovation management and entrepreneurship and innovation policy.

pp. 219-223

14:10 *Detection of False Data Injection Cyberattacks Targeting Smart Transmission/ Distribution Networks*

Ehsan Naderi (Southern Illinois University, USA); Abdullah Aydeger (Southern Illinois University, Carbondale, USA); Arash Asrari (Southern Illinois University, USA)

Integration of different infrastructures in the normal operation of modern-day power systems paves the way for adversaries to penetrate into the system and manipulate the data. This is because modern power

grids need to be monitored/controlled via information and communication technology (ICT). One of the most significant challenges associated with such power networks is the risk of operational issues (e.g., congestion, voltage instability, etc.) as a consequence of stealthy false data injection (FDI) cyberattacks bypassing bad data detection (BDD) algorithms embedded in both DC and AC state estimations. Toward this end, this paper develops a detection framework oriented toward multi-layer perceptron (MLP) neural networks (NNs) to protect the measurements to be processed by power system operators in the upper level. Levenberg-Marquardt (LM) backpropagation, which is a network training function updating the NN's weight/bias based on LM optimization, is implemented to train the developed NN. A mean absolute percentage error and mean of squares of the network errors are considered to assess the accuracy of the prediction. The developed feed-forward neural network tracks the measurements (e.g., active and reactive powers, voltage magnitudes, etc.) to find the relationship between them to warn the system operator in case of systematic manipulation in the dataset. The effectiveness of the proposed detection framework is validated on the IEEE 14-bus transmission system and the IEEE 33-bus distribution grid.

pp. 224-229

14:30 *A Sensor Selection Optimization Framework for Tracking CO2 Flow Movements in Carbonates*

Klemens Katterbauer, Abdallah A AlShehri, Abdulaziz Al Qasim and Ali Yousif (Saudi Aramco, Saudi Arabia)

4th Industrial Revolution (4IR) technologies have assumed critical importance in the oil and gas industry, enabling data analysis and automation at unprecedented levels. Formation evaluation and reservoir monitoring are crucial areas for optimizing reservoir production, maximizing sweep efficiency and characterizing the reservoirs. Automation, robotics and artificial intelligence (AI) have led to tremendous transformations in these domains in subsurface sensing, in particular. In this work, we present a novel 4IR inspired framework for the real-time sensor selection for subsurface pressure and temperature monitoring, as well as reservoir evaluation. The framework encompasses a deep learning technique for uncertain estimation of sensor data, which is then integrated into an integer programming framework for the optimal selection of sensors to monitor the reservoir formation. The results are promising, showing that a relatively small numbers of sensors can be utilized to properly monitor the fractured reservoir structure.

Presenter bio: Dr. AlShehri (Senior Member,IEEE) is the champion of Deep Diagnostic team with Reservoir Engineering Technology in EXPEC Advanced Research Center, Saudi Aramco. He received the Ph.D. degree in Wireless Sensor Network from Georgia Institute of Technology, Atlanta, USA. He received the M.S. degree in wireless communication from Concordia University, Canada and the B.S. degree in electrical engineering from King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. He is undertaking various industry-leading research projects to develop novel technologies to increase hydrocarbon discovery and reservoirs recovery capitalizing on 4th Industrial revolution (4IR) technologies and Artificial Intelligent (AI) technologies. He received several national and international awards including 2019 World Oil New Horizons Idea Award on the FracBots Technology. He deployed many technologies, has 20+ patents (granted & disclosed) and 40+ publications (Journals,book chapters,conferences).

pp. 230-234

PS11: Sustainability Management III

Room B

Chair: Srihari Yamanoor (Self, USA)

13:30 *Non-Intrusive Electric-Vehicle Load Disaggregation Algorithm for a Data-Driven EV Integration Strategy*

Anthony James (Southern California Edison, USA); Alec Zhixiao Lin (SCE, USA)

Electric vehicle (EV) charger demand has increased from 1.44kW to between 3.3kW and 17.2/19.2kW in the past 10 years - 3 to 17/19 times the average consumption from a single home. By 2045 EV penetration will on average grow by 34x (GWh) from today in Southern California Edison's (SCE) Territory. To develop a data-driven utility EV integration strategy, EV customer charging behaviors need to be well understood. Therefore, EV loads need to be disaggregated from household meter data to develop enterprise forecasting and distribution planning methodologies, as well as distribution standards. Another key application of the results in this paper is to help justify rate recovery on capital expenditures. is the use in CPUC Generate Rate Case decisions, which are also tied to how utilities earn revenue. EV telemetry is also not available to the utility. In this paper, we present a light-weight efficient EV disaggregation methodology, using real power measurements from advanced meter infrastructure (AMI) meters, and demonstrated how the results can enable several new planning capabilities. The algorithm was run on real-world test at scale (~62,000 EV customers), and on low-sample rate (i.e., hourly) data where the metered loads are less distinguishable from each other. The algorithm doesn't require extensive feature extraction, and training data as with supervised machine learning algorithms, and is therefore efficient and lightweight which means the algorithm doesn't require significant computational capability, and time to process.

pp. 235-242

13:50 *Design and Economic Analysis of a Net-Zero Water and Energy Single-Family Home That Meets Affordable Housing Criteria in Florida*

Kurt Wurthmann (Nova Southeastern University, USA)

This presentation discusses the features and economic feasibility of a design for a detached, single-family home that is consistent with a decentralized approach to achieving net-zero water and energy outcomes and meets the criteria for affordable housing in Florida. The design integrates well-established passive approaches to water and energy conservation with new technologies in electric composting toilets and PV arrays, charge controllers, and inverters, in hybrid, grid-connected, net-zero energy systems. It is found that, even without considering potential cost reductions available through governmental programs designed to support the implementation of sustainability measures in homes, the proposed design for a net-zero water and energy single-family home would meet the affordable housing criteria in Florida's Palm Beach County for both moderate- and low-income households.

pp. 243-244

14:10 *Using Smart Meter Data and Machine Learning to Identify Residential Light-Duty Electric Vehicles*

Anthony James (Southern California Edison, USA); Alec Zhixiao Lin (SCE, USA)

The growing adoption of electric vehicles (EVs) poses new challenges to power grids. To upgrade the grids with the increasing demand from charging EVs and from the change in customers consumption behaviors, utilities need to know where EV customers are. However, ownerships of EVs are not always known to utilities. The paper presents a methodology on how to use AMI (Advanced Metering Infrastructure) data and apply ensemble method of machine learning to identify residential customers with EVs. We will focus

on such aspects as how to do sampling to reduce effects of external factors associated with other high-usage home appliances, how to create and evaluate variables for enhancing modeling and how to apply ensemble methods to arrive at the estimating or forecasting needed for grid enhancement.

pp. 245-251

Friday, April 22 15:00 - 16:00 (America/Los_Angeles)

K6: Nuclear Power for a Sustainable Future

Steven Mirsky, NuScale Power

Room: Ballroom

Chair: Sharan Kalwani (Oakland University, USA)

This presentation addresses the global reality of what our world's population is lacking to provide a reasonable standard of living. A brief history of NuScale Power and our unique NRC-licensed small modular reactor design is discussed along with our microreactor. This is followed by information on how nuclear power can be used for a wide spectrum of industrial activities to replace fossil fuels, work with renewable power, and provide critical energy infrastructure. The benefits of nuclear power for reliable base loaded electricity, hydrogen production, clean water are highlighted. In addition the safety and low environmental impact of nuclear power in comparison to fossil and renewable power is also addressed in this presentation.

Friday, April 22 16:10 - 17:30 (America/Los_Angeles)

PNL2: Panel: Developments in Nuclear Energy

Room: Ballroom

Chair: Sharan Kalwani (Oakland University, USA)

Moderator: Sharan Kalwani

Nuclear power continues to develop technologically. Abundant energy is the base for advanced societies. We are being squeezed by two forces. The first is that our coal and oil burning does inflict lethal (yes, lethal) damage. The second is that coal and oil have finite resource lifetimes. They are a fixed resource that we burn huge amounts by the minute. This panel will discuss trends in the nuclear power industry.

Panelists:
* Steven Mirsky, P.E., Senior Technical Advisor, Research Collaborations, Office of Technology, NuScalePower, Greenbelt, Maryland, USA.
* Marley Smith, Nuclear Test Engineer, Puget Sound Naval Shipyard, Seattle, State of Washington, USA

* Dr. Charles Hawkins, Professor Emeritus, ECE University of New Mexico, Affiliate Professor University of Florida.

Friday, April 22 17:40 - 17:55 (America/Los_Angeles)

WUP2: Day 2 Wrap Up

Room: Ballroom

Chair: Sharan Kalwani (Oakland University, USA)

Friday, April 22 18:00 - 18:30 (America/Los_Angeles)

SPC2: SPATIAL CHAT

Networking

Room: Spatial Chat

Saturday, April 23

Saturday, April 23 7:00 - 8:00 (America/Los_Angeles)

OPK3: **Opening Remarks & K8:Powering Advanced Air Mobility**

Dr. Stefan Breunig - Head of Strategy, Rolls-Royce Electrical

Room: Ballroom

Chair: David Gonzalez (IEEE, USA)

Electrification in aerospace is currently driven by developments in the Advanced Air Mobility segment. Hybrid and all-electric Commuter and eVTOL aircraft will transform existing markets or even create completely new markets. The technology to make this happen is there and the route to certification is getting more and more defined.

This is the time to think about the next steps and upcoming challenges: How do we maintain these aircraft? How can we deploy the required charging infrastructure? And what role will digitally-enabled services and new business model play?

Saturday, April 23 8:10 - 9:40 (America/Los_Angeles)

PNL3: Panel: Evolving Aviation Ecosystem

Room: Ballroom

Chair: Siobhan M Dolan Clancy (& SDC Business Consulting Ltd., Ireland)

We are now seeing a fundamental paradigm shift in the way the aviation sector is embracing a net-zero emissions target by 2050, with a common understanding that it will take multiple stakeholders working together to make it possible. There is a coming together of industry stakeholders including

airlines, airports, aircraft /engine manufacturers, fuel suppliers as well as government and regulators in declarations of commitment and partnerships to work together to reach the aggressive emission reduction target while the industry is forecasting passenger numbers and air traffic to double in the same timeframe.

While aviation has historically been quite successful in leveraging technology to reduce its contributions to climate change, clearly there is more to do. More recently, technological advancements in aircraft/engine design and manufacturing, alternative jet fuels, airport and air traffic management, and maintenance practices have sustainability as part of its core value proposition.

This panel of aviation experts will take a deep-dive into the challenges and opportunities within sustainable aviation including technology innovation, R&D collaborations, regulatory regimes, infrastructure and financing with the ultimate goal of achieving net-zero emissions.

Key Discussion Points:
* What will air transport in the future look like?
* Airframe and Propulsion Technology innovations - challenges and opportunities
* Challenges in ensuring sustainable Alternative Jet Fuel supply and ways to overcome them
* Airport infrastructure and services needed to build net-zero emission aviation ecosystems
* Evolving regulatory regimes to achieve sustainability targets
* Sustainability as a key enabler to aircraft technology innovations

Moderator: Siobhan Dolan Clancy, Founder & CEO of SDC Business Consulting Ltd.

Panelists:
* Steve Csonka, Executive Director, CAAFI (Commercial Aviation Alternative Fuels Initiative)
* Val Miftakhov, Founder & CEO of ZeroAvia
* Melinda Pagliarello, Managing Director, Environmental Affairs at the Airports Council International - North America (ACI-NA)
* Ms. Valentina Vecchio, Sustainability Policy& Partnerships Regional Lead, Europe - Boeing Corporation
* Dan Wolf, Founder and Executive Board Chairman, Cape Air

Saturday, April 23 9:50 - 10:50 (America/Los_Angeles)

K9: Sustainable Ecosystem Model for a Regional Airport

Jean Louis Debauche - Founder and CEO of JLD Consultant, Co-Founder of ZE-Glue Limited

Room: Ballroom

Chair: Siobhan M Dolan Clancy (& SDC Business Consulting Ltd., Ireland)

The Aviation industry has been on a journey to reach the future of carbon-neutral air transportation across the globe for four decades and has already made significant achievements through technological advancement and improvements in operations and infrastructure. Now as the aviation industry has committed to Net Zero Carbon emissions by 2050, it will require a fundamental change in how the industry comes together as an Ecosystem of stakeholders to deploy the technological advancements necessary to reach the net zero targets in the given timeframe.

This talk will present a case study to establish a Sustainable Aviation EcoSystem Model for a Regional Airport whose primary objective is to address some key challenges around a rapidly evolving energy supply and distribution system, airport infrastructure and different types of aircraft technology deployment.

Saturday, April 23 11:05 - 12:05 (America/Los_Angeles)

K10: A Bright Era for Electrical in Aviation

Dr. Hao Huang, Retired Technology Chief - GE Aviation Electrical Power

Room: Ballroom

Chair: Justin Y. Shi (Temple University, USA)

Aviation is moving into a very special, bright era. The speaker will talk about the challenges and opportunities that Aviation has been facing, and the new roadmap necessary to overcome these challenges and to be ready and successful over this bright era. The speaker will then go through some key perspectives of aviation electrification, which include Electrical Engineering Technology perspective, Additive Manufacturing perspective, WBG perspective, advanced digital perspective, and Gg CO2 equivalent minimization perspective that electrical and electronics engineers need to be aware of, prepared for, and contribute to.

Saturday, April 23 12:20 - 13:20 (America/Los_Angeles)

K11: How Can We Decarbonize Commercial Aviation by 2050?

Zia Abdullah, National Renewable Energy Laboratory

Room: Ballroom

Chair: Susan R Dickey (USA)

U.S. airlines have set a goal to reduce carbon dioxide (CO2) emissions by 50% by 2050 compared to 2005 levels. Aircraft and engine manufacturers have improved efficiency by 130% compared to 1978 levels, however additional efficiency improvements in planes and engines are not likely to be sufficient. The current state of technology readiness for battery electric and hydrogen fueled aircraft is relatively low and is unlikely to be advanced and scaled up rapidly enough and sufficiently to meet 2050 decarbonization goals.

"Drop-In" Sustainable Aviation Fuels (SAF) which have low Carbon Intensity, and which can be safely used in place of conventional Jet-A fuel are the only option that airlines will have in the near-medium term to meet their 2050 decarbonization goals. One challenge for providing SAF is that the size of the jet fuel market is large and growing. US demand was 26 billion gallons in 2019 and is expected to reach 35 billion gallons by 2050. Another challenge is that the price of SAF today is higher than petroleum-based Jet A fuel. Fuel price is a hurdle because fuel is 20%-30% of the operating cost of an airline. SAF are required to be approved under the ASTM D4054 evaluation and qualification process before becoming an approved Annex in ASTM D7566 and be permitted for use in commercial aircraft.

This presentation will provide an overview of the biofuels research at the National Renewable Energy Laboratory, some novel SAF pathways that are under development, and opportunities to accelerate scaleup, approval and deployment of these fuel production pathways to meet the commercial aviation industry's decarbonization goals.

Saturday, April 23 13:35 - 14:35 (America/Los_Angeles)

K12: Vehicle Management System Challenges in Emerging Air Mobility Aircraft

Brian Barker, President and CEO, Hummingbird Aero, LLC

Room: Ballroom

Chair: Jesus Aguila-Leon (University of Guadalajara, Mexico & Universitat Politècnica de València, Spain)

This talk will examine the role of the Vehicle Management System (VMS) in new eVTOL aircraft, the new roles and considerations in its design, and the challenges presented by cost, weight, complexity etc.

Saturday, April 23 14:45 - 15:40 (America/Los_Angeles)

K13: Planet Positive 2030: Prioritizing Sustainability for Technology

John C. Havens, Sustainability Practice Lead, IEEE Standards Association

Room: Ballroom

Chair: David Gonzalez (IEEE, USA)

Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to grow as the global mean surface temperature increases and reaches 1.5°C or higher above pre-industrial levels (1850-1900). Yet estimates of global emissions of nationally stated reduction goals under the Paris Agreement will lead to GHG emissions by 2030 that will not permit limiting global warming to 1.5°C by 2050 and beyond. We need responsible mitigation and adaptation measures to limit global warming and to adapt to the impact of the on-going changes to the climate, including the responsible transformation of society and infrastructure. IEEE's new Planet

Positive 2030 campaign, open for all to join, provides a forward thinking, multidiscipline process leading to a roadmap of measures for change and associated metrics with the goals to
* curtail global warming,
* help adapt to the impacts of the global warming already under way,
and, hence, to the well-being of people, animals, plant life (all life forms) for a healthy planet today, tomorrow and for the next seven generations and more.

Saturday, April 23 15:50 - 16:15 (America/Los_Angeles)

SPA: Student Poster Awards

Room: Ballroom

Chair: Sean Monemi (California State Polytechnic University at Pomona, USA)

Saturday, April 23 16:20 - 16:40 (America/Los_Angeles)

CLS: Closing Remarks & SusTech 2022

Room: Ballroom

Chair: David Gonzalez (IEEE, USA)