BOOK OF ABSTRACTS

INDUSTRIAL & COMMERCIAL USE OF ENERGY CONFERENCE

25-26 November 2019

The Riverclub, Observatory
CAPE TOWN , SOUTH AFRICA

2 Table of Contents

WELCOMING MESSAGE

TO DELEGATES OF THE 17th ICUE CONFERENCE

On behalf of the Organising Committee, I would like to welcome you all to the seventeenth International Conference on the Industrial and Commercial Use of Energy (ICUE). Thank you to the Conference Advisory Board, Technical Organising Team and the Editorial Committee, who have worked hard to establish this annual focus on the use of energy in the industrial and commercial sectors. This is a conference comprised of co-operation with many academics from various universities and particularly the four universities in the Cape Town surroundings. In addition, the continued support of SAIEE, SAIRAC and AMEU is noted. I also thank our partners in industry listed on our website, especially ESKOM, who have helped us to make this event possible.

This year we have a Workshop on Electric Transportation at our conference. Electric vehicles compared with fossil fuel vehicles would reduce the pollution of the atmosphere caused by exhaust emissions. The scale of charging stations connected to the grid would be increasing, and it is could also impact significantly on the power system. It was therefore important to bring experts in their fields together in a conference such as this, to discuss the matters related to an unfolding electric transportation market.

Moreover, this conference focuses the continued attention on, renewable generation, overall energy efficiency and the importance of developing and promoting the wise use of available energy sources and the impact of increased digitalization in the sensor and communication network associated in the energy sector. At the Cape Peninsula University of Technology, the Energy Institute continues to address these issues of national importance.

The conference appreciates greatly the opportunity of being able to share the views and experiences of the academics and industrialists who wrote papers for this event. Out of 65 papers entered only 41 papers was accepted for presentation after peer review. We therefore, invite you to share your research, results and enthusiasm at ICUE 2019, bringing together the ideas, concepts and findings that could be relevant to industrial communities and decision makers. This year, in the interest of a sustainable future, we have opted for full digital proceedings presentation. The Proceedings will be uploaded on the conference website for download on the 27th of November 2019, but the book of abstracts will be available online as well as on the USB drive provided to delegates. Proceedings will also be hosted on SSRN Elsevier Conferences, which we have applied for on this track.

A special thanks to our guests, keynote speakers, workshop specialists and session chairs. Again, thank you to all who availed themselves to do a presentation here at our conference. We wish you all a pleasant stay in the greater Cape Town area, We hope you enjoy our venue this year at the Riverclub and have a most enjoyable time in our city.

Prof Mohamed Tariq Kahn
Energy Institute

THE LANDSCAPE OF ELECTRIC VEHICLES AND THE ENERGY SYSTEM

Presenter: Hiten Parmar has been actively pioneering the electric vehicles and smart grid sector since 2013. He currently stands as an executive, thought leader and lead industry expert extending over 15 years in profession. Hiten also serves as liaison for multiple forums locally and internationally across energy and mobility sectors respectively.

Encompassed with a Master's Degree in Electrical Engineering and Honours in Business Administration, Hiten's passion extends across contributing to advancements within the industry globally through the deployment of technological interventions to solve major economic, competitiveness and societal challenges.

Weblink
https://za.linkedin.com/in/hiten-parmar-2847b833

RAW MATERIALS TRANSPORTATION: COMPARISONS AND OPTIONS

The transportation sector, contributing about 13% of total emissions, is the second-highest contributor to the South Africa's greenhouse gas emissions. To decrease emissions the focus and effort is usually on privately owned smaller passenger Electric Vehicles (EV's).

This presentation however provides information on, and compares the benefits of the various types of solutions for transporting freight and raw materials.

Presenter: Karel Steyn

ENERGY TRANSITIONS IN TRANSPORT: SUPPLY-SIDE RISKS & OPPORTUNITIES

Transport is a large consumer of energy in South Africa and vital for economic development. Currently the transport sector consumes 28% of final energy, the bulk of which is in the form of liquid fuels. Supply interruptions are costly to the economy and dynamic strategic planning is required to ensure that there is sufficient and appropriate supply infrastructure at minimum cost.
A linked economy-energy-environment optimisation model for South Africa is used to gauge the economy wide impacts of a transition in vehicle technology and fuel demand. The model, SATIMGE, comprises a technology rich representation of economic sectors coupled to a CGE model which determines sector growth in response to energy costs and investment in energy infrastructure. Results suggests that a progressive decline in demand for liquid fuels with the emergence of cost-competitive alternative transport technologies; in tandem with the investment required for the Euro 5 fuel standard from conventional crude oil refineries, may warrant an early retirement of the CTL facility, possibly as soon as 2030 with a preference for the importation of refined product to cater for the residual domestic demand. In addition to the risk of stranded investment in a new refinery; owing to the nature of the integrated fuels-chemicals complex in South Africa, domestic chemicals production may require investment in alternative process routes and feedstocks. A confluence of pathways of such an energy transition in transport presents an opportunity to develop low carbon, or carbon neutral, energy supply infrastructure for future fuel, and feedstock, supply for which electricity and hydrogen are highlighted as key future transport fuels.

PV-RO DESIGNER OF A PV SYSTEM-POWERED DESALINATION PLANT - CASE STUDY

Energy and water signify two resources of outmost importance for developing countries, mainly due to rapidly increasing population and growing need for upgrading their standard of living to an acceptable one. Photovoltaic system (PVs) provide a viable means for decentralized energy and water production in arid areas, which also usually present on abundant solar resource. Recently, Libya is suffering from electricity shortage for many reasons. In order to cover the electricity shortage from the utility grid, this work presents a computer application to have an alternative power supply to operate reverse osmosis (RO) desalination unit using a photovoltaic system (PVs). PVs rely heavily on the availability of weather data (at selected sites) and the accuracy of predicting the load profile. Both parameters are not easy to be determined accurately, and this is a reason for the existence of this study by developing a computer application to obtain all these parameters that are required for the sizing of a stand-alone PV-RO system.

This computer application including friendly interface is applied in one of water plants of West Zawiyah, Libya called “Soquia Water Company”, as a case study. The develop computer application can be applied to any site.

Presenter: Ali M. Almaktoof was born in Libya in 1978. He received the B. Eng. from Al-Tahady University, Libya in 2001 and M.Sc. from University of Tripoli, Libya in 2008, and DTech from CPUT in 2015 all in electrical engineering. He is a member of Institution of Engineering and Technology (IET) and World Society of Sustainable Energy Technology (WSSET). He is an active member of the Centre of Distributed Power and Electronics Systems and Energy Institute at CPUT. Dr. Almaktoof research interests include control of power converters, predictive control, multilevel converters and renewable energy systems applications.

OPTIMAL PATH FOR AN ENERGY-EFFICIENT NATURAL GAS TRANSMISSION MAINLINE: A CASE STUDY OF ESCRAVOS SOUTHERN NIGERIA

An electrical method of analysis is deployed to analyze the more complex proposed natural gas pipeline network. A case study of Escravos between Warri to Enugu in Southern Nigeria is considered. A MatLab program is written to implement the Dijkstra's algorithm for shortest path problems using the results of pressure losses on alternative branches from the aforementioned analysis as inputs.

This is done to determine the optimal path or optimal sequence of connection of nodes for the natural gas transmission mainline from Escravos to Enugu considering the topography of the area. The results from this analysis shows that the optimal sequence of connection of nodes which is also the energy-efficient path, is determined to be from node 1 to node 2 to node 5 to node 8 to node 10 It is also discovered that the case study area is fairly plain because altitude/elevations in the area are not significant enough to affect the resulting optimal path.

Presenter: Ezekiel O. Arogunjo received B.Eng . and M.Sc. in Electrical and Electronic Engineering from the Federal University of Technology, Akure, Nigeria and University of Ibadan, Nigeria respectively. He is currently a Lecturer in the Department of Electrical and Electronic Engineering at the University of Ibadan, Oyo State, Nigeria. His research interests are Adaptive Control, Robotics, Artificial Intelligence, Biomedical Engineering, Network Design and Optimization. Email: arogunjo.eo@gmail.com

MODELLING OF A SOLID OXIDE FUEL CELL MICROGRID SYSTEM FOR A MEGAWATT LOAD

Fuel cell systems are expected to play a key role for power generation in various applications ranging from domestic, commercial to industrial. A solid oxide fuel cell is one of the types which is suitable for high-power demand. It can power diverse systems including trains, ships, vehicles as well as supplying industrial and residential loads. In this study, a microgrid using a 1.4 MW solid oxide fuel cell is considered operating in grid connection mode under 600 volts. A grid connected inverter is modelled and controlled as a closed loop control system to supply a 1.2 local load while feeding any excess into the grid. The inverter control scheme comprises voltage and current regulators to provide a good power factor and satisfy synchronisation requirements with the utility grid in synchronous frame.

The frequency and phase of the inverter are synchronised with those of the grid through a phase- locked-loop. An LCL filter serving as an interface between the inverter and the grid is used to minimise harmonics produced by the grid-connected inverter. Matlab/Simulink environment is used for the modelling and simulation. The results obtained show good performance of the proposed microgrid as well as the inverter design and control approach with a low total harmonic distortion of about 0.5%.

Presenter: Khlid Ben Hamad was born in Libya in 1982. He received his BSc. in 2008, M.Sc. in 2012, all in electrical engineering. He is currently studying toward a Doctorate degree (DEng) in Electrical engineering at the Cape Peninsula University of Technology in South Africa. His research interests include Fuel cell, PID controllers, DC-DC Converters and multilevel inverters.

LESSONS LEARNT FROM THE PLANNING PHASE OF BATTERY STORAGE INTEGRATION AT A UTILITY SCALE LEVEL IN SOUTH AFRIA

Eskom has embarked on a project to install distributed battery energy storage to support the network and provide ancillary support to the national grid.

This presentation shares the planning approach that was followed and the experiences gained during the planning phase of the project. The technical evaluation of the storage integration to support both local and national constraints is shared in the presentation.

Presenter: Kurt Dedekind

A 100% RENEWABLE CHP SYSTEM FOR A REMOTE AREA POWER SUPPLY

Most remote locations in Africa are non-electrified due to the sites' location as opposed to the main utility grids. Studies carried out to assess the possibilities of extending the grids to reach these areas have shown in most cases that the solution is not economic due to the inability of the inhabitants to afford the electricity bills, in addition to the lack of important economic activities. An alternative solution is the use of off-grid power systems. Different configurations of off-grid power systems may be possible depending on the available resources, however, as remote area activities are based on farming and agriculture, organic matters from plants and animals can be used as primary energy to produce biogas and generate electricity and heat. In this study, a renewable combined heat and power (CHP) system using biogas is proposed as a solution to meet the electrical and thermal loads of a remote area in the Eastern Cape province of South Africa.

The objective of the study is to assess the potential of implementing a biomass-based combined heat power system in a rural area by considering a total of twenty agricultural households. It is considered that a single household has an average of five species of livestock including cattle, sheep, goats and pigs. The type of biomass used in the study consists of manure released by the selected livestock. A techno-economic evaluation is carried out using the electrical and thermal load requirement of the twenty households. Sensitivity analyses are carried on evaluating the Net Present Cost and Cost of Energy in case the discount and inflation rates vary. The modelling and simulation is carried using Homer Pro software.

Presenter: Felicidade P.K. Garcia has a BSc in Mechatronics Engineering from the Universidade Metodista de Angola. She is currently enrolled for a MTech in Energy Systems at the Cape Peninsula University of Technology.

VOLTAGE FLUCTUATION ON DISTRIBUTION GRID USING STATCOM WITH DROOP CONTROL AND DER

In this paper, the reasons and procedure of voltage fluctuation are analysed with the help of a distribution grid. The main model of the power grid simulated power system has a single feeder and four distribution points (DPs) namely DP2, DP3, DP4, and DP5 located at equal distances along the grid. Furthermore, one more DP is also located close to feeder DP1 and is termed as the point of common coupling (PCC).

The sixth distribution point, DP6, is used as an option for the future and is located at the end of the line. The STATCOM used for voltage control can be connected close to PCC at the beginning of the line or in series at the end of the line. The STATCOM when connected to PCC, controls the voltage there at PCC i.e. DP2.When connected in series at the end of the line, it controls voltage of DP5, also known as the local voltage.

Presenter: G. Gupta

EXPERIMENTAL ANALYSIS OF AN INTEGRATED AQUAPONICS AND STAND-ALONE SOLAR PHOTOVOLTAIC SYSTEM

A stand-alone photovoltaic system was required to produce power for the prototype Modular Solar Powered Aquaponics System (MSPAS) developed at the Cape Peninsula University of Technology located in South Africa's, Western Cape region. MSPAS utilizes solar energy such as solar photovoltaic panels to generate electricity to power a submersible pump and two light emitting diode (LED) lights. The focus of this paper was to validate the design of the PV system with experimental results. The results indicated that over the course of 8 days, during the winter month, the PV system was able to generate an average of 1.167 kWh during days with average solar radiation values of 586 W/m2 an efficiency for the PV array determined to be 8.5 %.

The prototype showed promising results and that the design was able to meet the requirements by powering the system during moderate to adverse weather conditions. Therefore, the integration of stand-alone PV systems and aquaponics could prove to be viable option that further promote renewable energy and environmental sustainable perspectives.

Presenter: Fareed Ismail obtained his Master's Degree in Mechanical Engineering in 2013 from the Cape Peninsula University of Technology (CPUT). He is an academic at CPUT with 16 years naval engineering design experience. He is a key figure in a community outreach programme; using his Doctoral research, he implemented a project that spans beyond the confines of academia, by expanding the field of multidisciplinary knowledge in the areas of engineering, design, renewable energy, marine life and agriculture, thus enriching the lives of children in a needy community in the Western Cape region of South Africa. He received CPUT's Outstanding Community Engagement Award in 2015 and his community project won the South African Provincial and National Early Childhood Development Programme Awards (2015)

THE DEVELOPMENT OF A WHOLE-BUILDING ENERGY BASELINE MODEL FOR THE MEASUREMENT & VERIFICATION OF A COMMERCIAL BUILDING

This paper focusses on a whole-building energy baseline model that was developed for an office building in South Africa. The research was driven by the 12L Tax Incentive which was promulgated in December 2013 and will be operational until 1 January 2022. Currently, the 12L Tax incentive awards energyefficient users with a 95 cents tax incentive per kWh of measured and verified savings achieved. These savings are however directly influenced by the level of uncertainty of the baseline model which is governed by the SANS 50010:2011. The SANS 50010:2011 standard states that uncertainty shall be managed to deliver conservative results in order to guarantee the credibility of the reported energy performance.

The uncertainty should be applied to the savings and not the overall energy use. Thus it has a direct effect on the quantity of the savings determined. The aim of the conducted research was to develop a baseline that would report the maximum savings that fall within acceptable uncertainty and confidence levels as required by the standard. A total of six models were developed and evaluated during this research. The results found that the Day-Time-Temperature 24 x 7 x 12 model delivered optimal results with a precision of 8.9% at a 80% confidence level. Compared against the worst performing model, the savings increased by 59,493 kWh and the associated tax incentive more than tripled with an increase of R 67104

Presenter: Werner H Kaiser received his B-Eng and M-Eng degrees in Mechanical Engineering from the North-West University, in 2004. Currently, he is a senior lecturer in the School of Mechanical at the North-West University with his research work focusing on modelling energy applications.

ESTIMATING THE SOUTH AFRICAN INDUSTRIAL HEAT DEMAND POTENTIAL FOR CO2 HEAT PUMPS.

The industrial sector is the largest thermal energy consumer in South Africa, accounting for 80% of the total heat demand. Currently, thermal energy is primarily supplied by fossil fuels and electricity. Heat pumps have the potential to reduce energy demand in this sector. In order to develop this application one need to determine which industrial sectors have the highest potential for the integration of heat pumps. This paper investigates the potential for industrial heat demand below 100°C for 13 sectors. Based on the IEA [1] data, the total heat demand below 100°C is about 220 [PJ/annum].

The sector with the highest theoretical potential is the non-specified industry with a share of nearly 80.4% which is equal to 176.5 [PJ/annum]. The chemical and petrochemicals industry has the second largest potential with a share of nearly 9.9% or 21.8 [PJ/annum]. The remaining sectors all together make up the rest of the 9.6% or 21.1 [PJ/annum].

Presenter: Werner H Kaiser received his B-Eng and M-Eng degrees in Mechanical Engineering from the North-West University, in 2004. Currently, he is a senior lecturer in the School of Mechanical at the North-West University with his research work focusing on modelling energy applications.

A SIMULATION STUDY OF POWER AND ENERGY REQUIREMENTS OF AN ELECTRIC VEHICLE FOR HYBRIDISATION PURPOSES

This work presents a matlab based simulation of an electric vehicle's powertrain. These powertrains are typically made up of a traction motor, a power electronics interface, and a high energy storage module such as a battery. In an attempt to study power interchange within these components when in motion, a data reliant model of an electric vehicle is developed.

The simulation is not solely reliant on the mathematical constraints that goes with analyzing particular sub systems of these vehicles, it also makes use of data extracted from the different components within these vehicles. For example, the temperature, State of Charge (SOC), Open Circuit Voltage (OCV), and internal resistance variations are factors that are most affected as a battery pack undergoes charge and discharge cycles. Also, variables like the electric motors torque, its efficiency, and angular velocity are also affected as the motor attempts to put these vehicles in motion. With such data properly extracted and documented from specifically tested and already commercially marketed EV's. A study of the flow of power and energy within these vehicles can be computed. This study creates a foundation for more research and development into hybridizing electric vehicles.

Presenter: Michael Khan Tal Received a Btech degree in Electrical and computer engineering in 2012 at the Cape Peninsular university of Technology. Currently in the process of completing an M-Eng degree, He has worked as an electrical specialist and a junior lecturer in the fields of virtual prototyping and embedded systems. His research interest includes interaction of computer simulations and embedded systems, Intelligent Energy management systems and power electronics.

IRRIGATION IMPLEMENTATION COSTS REDUCTION IN SOUTHERN AFRICA USING ARTIFICIAL INTELLIGENCE - LITERATURE STUDY

The use of renewable energy technologies in the agricultural sector is minimal, with the evolution of technology and where it is headed, farmers are forced to adopt efficient methods of operation to increase production and minimize costs in every way they can.

The paper encompasses challenges, current implementation strategies, need for other solutions and recommendation to alleviate the issue around technology adaptation in South Africa agriculture sector. Furthermore, a futuristic approach in the form of Artificial Intelligence (AI) as a control technique is advocated and its need has to be explored for water conservation and irrigation cost savings.

Presenter: Ms Itumeleng Mako holds a National Diploma in Electrical Engineering from the Tshwane University of Technology and currently pursuing a B.Tech in Electrical Engineering from the same institution. At present he is also the Research Assistant and Measurement and Verification Support at the Centre for Energy and Electric Power with a great interest in Renewable Energy for Rural Development and Energy Efficient Facilities.

IMPROVING BY-PRODUCT GAS UTILISATION IN STEEL MILLING OPERATIONS

The South African steel-making industry remains globally uncompetitive due to strenuous financial conditions and increasing energy costs. Declining production figures, decreasing exports and increasing imports have adversely affected the market profitability. Energy contributes 20% towards the total operational costs of an integrated steel enterprise. Maximum usage of alternative energy sources is required to alleviate costs. By-product gases are combustible energy carriers, containing almost 18% of the energy input of production processes. Coke oven gas (COG) was found to be competitive with natural gas and applicable for high-temperature requirements, such as in steel reheating furnaces.

However, fluctuations in the calorific value (CV) and composition of COG cause combustion and temperature instabilities. As such, quick reactions from human operators are required to adjust the air -fuel ratio (AFR) to maintain furnace stability using a trial-and-error method. This causes energy inefficiencies and production losses. A methodology was developed to predict and adjust the AFR according to the CV of COG using adaptive control strategies. The control strategy uses historic behavioural patterns of the furnace to determine the required AFR. Pilot studies on a billet mill reheating furnace have shown a 95 – 98% improvement in AFR adjustment accuracy. Potential cost savings of R7.5 million/annum in natural gas purchases were identified for this case study. Investigations into applying the developed solution to similar challenges is encouraged.

Presenter: Miss M.B. Mampuru holds a Master's degree in Chemical Engineering and is currently enrolled for PhD studies at the North-West University's Centre for Research and Continued Engineering Development (CRCED) in Pretoria.

ASSESSING THE EFFECTS OF ENGINE LOAD ON COMPRESSION IGNITION ENGINES USING BIODIESEL BLENDS

this study evaluated the performance of a diesel engine operated with waste plastic biodiesel fuel blends. At all engine loads the emissions of carbon monoxide (CO), unburnt hydrocarbons (UHC) and carbon dioxide (CO2) were low compared to conventional petro-diesel (PD), but the emissions of NOX were higher. The brake specific fuel consumption (BSFC) for the blends dropped while the brake thermal efficiency (BTE) continued to increase with load for all blends until intermediate load when it decreased. Compared to PD fuel, CO emissions for blend 95/WPPO5 at all engine speed idling modes were 285 ppm, 298 ppm, 320 ppm, and 388 ppm while PD emissions were 270 ppm, 295 ppm, 315 ppm and 365 ppm respectively. The values for UHC for blend 95/WPPO5 at all engine speed idling modes were 35 ppm, 28 ppm, 22 ppm, and 18 ppm compared to PD fuel with 20 ppm, 25 ppm, 30 ppm, and 40 ppm respectively.

The NOx emissions for PD fuel at all engine speed idling modes were 175 ppm, 225 ppm, 300 ppm and 375 ppm compared to blend 95/WPPO5 at 195 ppm, 245 ppm, 335 ppm, and 397 ppm. The BSFC values for blend 95/WPPO5 at all engine idling speed modes were 0.48 g/kW.h, 0.41 g/kW.h, 0.35 g/kW.h and 0.4 g/kW.h compared to PD at 0.45 g/kW.h , 0.39 g/kW.h , 0.33 g/kW.h and 035 g/kW.h respectively.

Presenter: Semakula Maroa received his BT in automotive from University Eastern Africa Baraton in Kenya in 1998. He has worked in the transport industry for 19 years in various capacities. He also holds a Master of Science engineering from the University of Kwa-Zulu Natal in Durban, South Africa, where he is currently enrolled as a PhD candidate and research fellow in the school of Engineering Howard Campus. He has published more than 10 publications both in peer reviewed journals and conferences. His greater interests are in emissions, energy and renewable energy from waste biomass, using thermal processes.

PRACTICAL LOW-COST METHOD TO SUSTAIN MINE COMPRESSED AIR SAVINGS

Efforts to ensure a sustained growth path for the mining industry are vital for its survival, as well as the communities that depend on it. Mining companies in South Africa thus need to focus on reducing their operational costs in order to remain competitive. Mines can reduce their operational costs by optimising compressed air production and curbing oversupply. However, complex and expensive solutions are impractical, and the need for a simple, lowcost solution to match compressed air supply with the required demand is evident. A simplistic and inexpensive step-by-step methodology was subsequently developed.

The methodology focused on identifying cost-saving initiatives to reduce compressed air network inefficiencies. These inefficiencies were evaluated, and a suitable solution strategy was developed. The methodology was implemented on the compressed air network of Mine A and proved to have no negative effects on the production of the mine, while annual energy cost savings of R1,1-million were shown to be viable.

Presenter: George E. Mathews is a Research Assistant at the North-West University's Centre for Research and Continued Education Development (CRCED) in Pretoria.

INTEGRATED SIMULATION OF COAL-FIRED POWER STATIONS

South African coal-fired power plants (CFPPs) are set in a unique environment and are faced with unique challenges including ageing infrastructure, increased maintenance requirements, and reduced funds. A unique solution is required whereby plant performance can be maintained, or even enhanced, through the use of efficient techniques that utilise the available funds in a cost-effective manner. A simulation-backed model could help improve the effectiveness of operation and minimise downtime. Simulation software has become an intricate part of the operation of modern companies, aiding in decision making, process predictions, scenario investigations, and optimising operations. In order to compare the available CFPP simulation software, six functional evaluation criteria were investigated, namely; training, digital twinning, scenario investigation, optimisation, real-time monitoring, and dynamic analysis. With these criteria in mind, a simulation model was constructed of a South African-based CFPP.

The model is based on a semiempirical thermohydraulic model. The results of the simulation were verified against measured plant data and was within 5% accuracy. Correct application of the model contributed towards maintenance scheduling, with an average daily profit per unit of R1.13 million. When extrapolated to all Eskom power stations, this value increases to over R1.6 billion per annum.

Presenter: Ian Mathews holds a BEng in Mechanical Engineering from the University of Pretoria. He is currently a post-graduate student at the North-West University's Centre for Research and Continued Engineering Development (CRCED) in Pretoria.

OPPORTUNITIES FOR ENERGY AND DEMAND REDUCTION IN HOTELS THROUGH AN ENERGY AUDITING APPROACH

Over the years the hotel and hospitality industry has become one of the largest business sectors that present opportunities for energy conservation. Exploiting these opportunities lead to the development of a sustainable industry. Chinhoyi University of Technology Hotel is a 3 star hotel that offers conference rooms, banqueting rooms amongst others, making it a busy institution. This paper focuses on opportunities for energy and demand reduction in hotel and tourism industry, an energy auditing approach: case study Chinhoyi University of Technology Hotel.

It aims at providing an overview of the current energy and demand profile as well as establishing sound and sustainable alternatives. In order to optimise the energy consumption of this industry, an energy audit is of importance - an analysis of thermal performance and energy systems of the building. Properly planned, designed and operated hotel facilities offer convenient environmental and economic advantages. Implementation of an energy management systems (EMS) in a hotel saves up to 40% of electric bills. The energy management system enhances control of various aspects including lighting and HVAC. These appliances are linked together through the Internet of Things. Evaluation and calculation of costs and payback period form the lifeline for an energy management programme. Cost savings are the driving factors for the success and longevity of the EMS programme. and targets for “before and after outage” was 0.979 and 0.992, respectively.

Presenter: Willard I Mazimbo holds a BSc degree in Fuels and Energy Engineering from Chinhoyi University of Technology. He is currently a graduate engineering trainee at Lighmart Engineering. From 2017 to 2018 he was a Climate Change Mitigation Officer in the Ministry of Environment, Water and Climate. He is currently a Unite 2030 Ambassador and is a member of the Africa Low Emissions Development Strategy Global Partnership.

DRYING RATE ANALYSIS USING A SMALL-SCALE SOLAR COLLECTOR FOR RURAL USAGE IN THE WESTERN CAPE, SOUTH AFRICA (NOVEMBER 2019)

Electricity is the most used type of energy in South Africa. It affects households socially and economically, in both metros and rural areas. The increase in the electricity demand and in the price of gas and coal has affected ESKOM the power provider, who implemented load shedding with serious consequences on both industries and families. Because of these economic constraints, the price of a kilowatt-hour has increased. Rural areas are the most affected by the high price of electricity and have to change their living style. One of the most important elements affected, which requires the use of energy is food storage. In South Africa, solar energy is the most readily accessible types of energy one may use to preserve and store food through drying. This paper compares the drying rate between fish, meat and apple fruit using a solar dryer that consists of a collector and drying chamber.

The system has a heat-absorbing box where sun radiation is trapped and air is used as a medium. An extracting fan is installed to circulate hot air in the chamber for drying purposes. Results show that weather conditions; temperature, atmospheric pressure, wind speed and humidity define the drying rate. It was concluded that not only weather conditions are important, but also material properties and size of the collector.

Presenter: B. L.Meyers is a Lecturer is a lecturer and researcher in Mechanical Engineering at Cape Peninsula University of Technology (CPUT). He obtained his Master of Engineering degree (MEng) at CPUT in 2018. His research focussed on Computational Fluid Dynamics.

MILK COOLING ENERGY OPTIMIZATION ON A DAIRY FARM THROUGH AN ENERGY AUDIT APPROACH

High energy cost in a dairy farm is of concern and in order to make the business viable serious energy efficient measures need to be taken into account. Mostly, in dairy farms, energy consumption is high during the cooling process of milk before it can be collected for processing. This study presents the optimization of the cooling process of milk on a dairy farm through an energy audit approach. A data acquisition system comprising of a power and energy meter, temperature sensors and flow meter was designed and built to monitor the energy consumption of the milk cooling process, the temperature of the milk and the flow of hot water in the dairy farm. The paper emphasizes the utilization of the waste heat to preheat water that is used for sanitation purposes within the plant.

Findings from the study revealed that harnessing low grade waste heat from the milk before cooling can lead to energy reduction in hot water heating as well as improves the load factor of the bulk milk cooler significantly. An efficient and economical design is considered for retrofit purposes or for new plant designs.

Presenter: Russel Mhundwa holds a PhD degree in Physics from the University of Fort Hare, B.Tech.(Hons) in Agricultural Engineering and MSc degree in Renewable Energy from UZ, Zimbabwe. He is presently with Fort Hare Institute of Technology. His Research interests are Energy Efficiency and Energy Management

EFFICACY OF ENERGY WHEELING TO ENDORSE RENEWABLE ENERGY GENERATION

Industry, which forms the lifeblood of South Africa's economy, is under threat as a result of increased electricity pricing and unstable supply. Wheeling of energy, which is a method to transport electricity generated from an Independent Power Producer (IPP) to an industrial consumer via the utility's network, could potentially address this problem.

This paper presents a technical and economic evaluation to determine the viability of wheeling 16MW wind or solar energy between an industrial consumer and an IPP via the utility's network in a regulated electricity market. Using DIgSILENT PowerFactory and HOMER Energy the viability has been evaluated based on levelized cost of electricity (LCOE); net present cost (NPC); distributed generation (DG) technology; DG distance from the load; available renewable resources and impact on network parameters. The results of the study show that (i) wind energy is the most viable economic option, (ii) the voltage profile at the point of common coupling (POC) increases as the distance between the load and DG increase, which has to be mitigated by using voltage control measures. Based on the results, wheeling of renewable energy could be a solution to address the electricity demands of industrial consumers.

Presenter: W. Murray received the MEng degree in electrical engineering from Cape Peninsula University of Technology (CPUT) in 2018. He is currently studying towards his doctorate in electrical engineering at CPUT. He is working in the private sector for a South African-based MV and HV electrical equipment manufacturer supplying electrical equipment and engineering services to renewable energy projects. He has a keen interest in renewable energy technologies and the impact on the future grid.

DESIGN OF A SUSTAINABLE AUTOMATED SOLAR POWERED AQUAPONIC SYSTEM – CASE OF ST PETER'S MBARE SECONDARY SCHOOL – HARARE, ZIM BABWE

As population is growing, limitations on natural resources is also increasing. Consequently, there is a need to use natural resources such as water and land efficiently as much as possible. Traditional farming methods depend on reliable rainfall. In the realm of rainfall variability, other methods are needed to avert famine. Currently, in Zimbabwe, aquaponic systems are being considered as the best way to avert famine. This study was done at St. Peter's Mbare Secondary School where there is complete and operational aquaponic system. The system basically faced the frequent power outages leading to interruptions in running of pumps. This impacted continuous oxygen flow causing the fish dying. However, Zimbabwe has enormous potential of solar PV not yet exploited.

The objective of this research was to harness solar energy and integrate it to traditional aquaponics thereby making the system sustainable and innovative (automated) supplied by a standalone PV system. A 1.6 kW solar PV array was sized to run an electrical load of 293.2 W meant of water pump, aerator and electronics devices. The system was automated using Arduino based system to monitor the pH, temperature and water flow velocity in the Aquaponic system. The designed system is scalable and would serve a model to be implemented in other localities.

Presenter: Tawanda Mushiri is a holder of BSc Mechanical Engineering (UZ), Master of Science in Manufacturing Systems and Operations Management (MSOM) (UZ) a PhD in Automation, Robotics and Artificial Intelligence (U.J) of machinery monitoring systems. He is currently a Senior Research Associate at UJ and Senior Lecturer at the University of Zimbabwe teaching Machine Dynamics, Robotics, Solid Mechanics and Finite Element Analysis. His research interests are Wind Energy and Industry 4.0.

DESIGN OF A HUMAN KINETIC ENERGY HARVESTING SYSTEM FOR A GYM USING MAGNETIC INDUCTION.

This article outlines the design of a machine that can be used in the gym for generating electricity in the process of exercising. The growing demand for energy coupled with diminishing resources increase the need for switching to renewable energy. Human power is one renewable source of energy that would make a gigantic difference as far as energy is concerned. One of largest sources of harvestable energy is the gym where energy that could be harnessed is wasted through sweat. In the fast growing demand for energy the designed machine reclaims that energy. The energy crisis is further worsened by inefficient use of energy hence there is need to also practice energy efficiency and conservation. The proposed design replaces convectional "power-hungry" treadmills that uses electric motors with power ratings up to 4.5 horsepower therefore saving about 66% of the electrical energy used in gyms. Research carried out by the authors show that, of the more than 30 registered fitness centers around Harare, most of them have monthly electricity bills that range up to US $3000.

Presenter: Tawanda Mushiri received his Bachelor of Science Honors Degree in Mechanical Engineering (2004-2008) and a Masters (2011-2012) from the University of Zimbabwe, Harare, and a Ph.D. from the University of Johannesburg, South Africa (2013-2017). He also obtained a Certificate with Siemens in Programmable Logic Controllers in the year 2013 where he worked with Scada and Link Programming. His doctorate involved fuzzy logic and automated machinery monitoring and control. Currently, he is a lecturer and Senior Research Associate at the university of Zimbabwe and University of Johannesburg, respectively. In the past (2012-2013), he has also lectured at the Chinhoyi University of Technology, Zimbabwe, lecturing mechatronics courses. He has also been an assistant lecturer for undergraduate students at Chinhoyi University of Technology, tutoring advanced manufacturing technology and machine mechanisms.

IMPACT OF DISTRIBUTED GENERATION ON THE ELECTRIC PROTECTION SYSTEM

This paper provides a study of the impact of distributed generation (particularly Solar and wind energy) on the electric protection system. Due to energy poverty, most countries globally are now open to the use of Distributed Generation (DG) such as wind and solar powered generators, South Africa being one of them. Based on previous research, numerous effects associated with the integration of DG on the protection system have been discovered and their solutions adopted to curb these problems.

However, it is still uncertain how the integration of these DG impacts the protection system. In this study, DigSilent PowerFactory software is used to simulate a network pre-and post-connection of DG according to the South African grid code requirements to reflect the power flow and fault levels. DigSilent software is also used to populate protection devices in the network such as current transformers, circuit breakers and relays. The main types of faults covered in the study are single-phase to ground faults on transmission lines and three phase faults on Busbars. The study focuses on Overcurrent Protection on the low voltage network by analysing the behaviour of the Inverse Definite Time Relays pre and post connection of DG in the event of a fault in the network. Furthermore, a case study on Distance relays applied on transmission lines is analysed clearly showing their behaviour with the connection of DG.

Presenter: Rufaro Mavis Mutambudzi attained her BTech degree at Cape Peninsula University of Technology in 2016. Since 2016 she has been working as a Design Engineer and Project Manager at Smart Energy SA in Cape Town South Africa. She Is currently pursuing her MTech degree In Electrical Engineering specializing In Renewable Energy. Rufaro Mutambudzi designed the DigSilent network analysed in this study, outlined the data and wrote the paper.

REVIEW ON EUTECTIC SYSTEM FOR TRANSPORT REFRIGERATION (NOVEMBER 2019)

This paper reviews the use of an alternative refrigeration system in refrigerated vehicles by using thermal energy storage systems. The application of thermal energy storage systems in transport refrigeration focusing particularly on latent heat phase change materials PCMs that have been used in recent years is reviewed. The majority of PCMs are found in building applications for space heating and cooling, greenhouse heating applications, solar cookers, and storage of solar energy for water heating. The focus of this work is on latent heat storage (LHS) materials for road transport refrigeration and their benefits in the refrigeration of perishable foodstuffs for short- and long-distance transportation.

The benefits of using LHS materials over a conventional mechanical vapour compression system are explored. This paper also centres on the need to develop new PCMs with high thermal cycles and minimal degradation to ensure effective performance in the transport refrigeration industry. Criteria for selecting suitable PCMs for different applications were summarised, and classification of PCMs based on their melting temperature and latent heat were tabulated. Heat transfer materials for increasing PCM performance were analysed as well as the effect of container material corrosion on PCM stability. The different thermal techniques for determining the properties of PCMs were summarised, and the accuracy of each technique was explored based on similar research work by other researchers. The PCMs that have been used in transport refrigeration as well as the thermo-physical criteria that are needed for different applications were analysed.

Presenter: A.U.C. Ndanduleni obtained a BTech degree from Tshwane University of Technology in 2016 and he is a MEng candidate in mechanical engineering at the same institution. As a graduate, his research interest is in transport refrigeration with focus on the application of phase change material.

THE THERMAL ANALYSIS OF A SEMI-OPEN HEAT PUMP DRYING SYSTEM: AN EXPERIMENTAL INVESTIGATION

One of the key advantages of heat pump (HP) systems is their ability to recover waste heat energy for useful input. In this study, the thermal performance of a heat pump drying system that recovers heat energy from the hot and moist exhaust air from the dryer was designed, constructed and examined. The performance of this semi-open air source heat pump system was investigated and analysed by varying the refrigerant charge, the condenser fan speed and the thermal expansion valve orifice size at ambient temperatures ranging from 23 – 26 □C. The results indicated that by increasing the charge in the system, the refrigerant mass flow rate, heating capacity and coefficient of performance (COP) of the system increased to a certain maximum point before maximum charging.

By increasing the refrigerant charge, both evaporation and condensation pressures of the system increased with condensation pressure indicating more sensitivity on the charge amount before optimum charging than evaporating pressure. The increase in refrigerant charge was observed to decrease the degree of superheat but increase the sub-cooling degree. At an optimum charge, the heating capacity for thermal expansion valve (TEV) of 0.3 mm diameter orifice is 15% greater than that of 0.2 mm diameter orifice. A system power consumption for □0.3 mm orifice was 3% greater than that of □0.2 mm orifice at optimum charge amount. However, the COP of □0.3 mm orifice was 18% greater than that of □0.2 mm orifice.

Presenter: Mr. Solomzi Marco Ngalonkulu received a B-Tech degree in Mechanical Engineering from University of South Africa (UNISA), East London, South Africa in 2012. He is currently doing M-Eng.: Mechanical Engineering with Tshwane University of Technology. Since 2016, he has been an active research member of refrigeration and heat pumps area.

TRNSYS VALIDATION OF A 1.5 AXIS TRACKING CONCENTRATED SOLAR PHOTOVOLTAIC THERMAL SYSTEM

This paper reports on TRNSYS simulation results on a hybrid concentrated solar photovoltaic thermal cooled collector, CSPVT. The system is composed of a 90Wp monocrystalline PV panel which is used to generate both electrical power and hot water for domestic use. The software was used to predict the total energy yield from a CSPVT. In addition to that, a prototype was built and tested to give actual energy yields.

An existing Campbell weather station located near the experimental site, logging 15-minute data of actual parameters such as: incident radiation, voltage and current, enabled comparison with the model's estimate. The electrical and thermal energy yields were closer to actual ones. Total energy production yield was 76% for Cape Town, South Africa, while TRNSYS predicted 82%. Thus, we conclude that, TRNSYS modelling can be used to predict the performance of the CSPVT at a location near the weather stations listed in the software's database. A capital cost analysis showed that over a 15-year life span, the CSPVT could possibly give a unit energy cost less than half of that from a conventional PV panel.

Presenter: N.E. Nteka, graduated with national diploma and BTech Mechanical Engineering degree from Cape Peninsula University of Technology. She is currently doing her Master of engineering while teaching assistant lecturer under the Mechanical Engineering department. She also works as a resident student assistant at Bellville Campus. She has done training at Sonangol P&P Angola working in the production and maintenance department for over a year.

AN ENERGY-EFFICIENT COGNITIVE RADIO BASED SMART GRID COMMUNICATION NETWORK ARCHITECTURE

With the introduction of an automated electric power system known as smart grid, issues relating to power quality, shortages and inefficiency has been solved, One vital foundation necessary for the sustainability and stability of smart grid (SG) is a secured, reliable, stable and efficient communication network infrastructure. The aim of this paper is to examine smart grid communication networks (SGCN) and propose a SGCN architecture that is energy efficient with the integration of cognitive radio technology.

The SGCN architecture is layered into the Home Area Network (HAN), Neighbourhood Area Network (HAN) and the Wide Area Network (WAN) and each layer is analyzed. The paper also examine the motivation behind the employment of CR in SGCN and the challenges involved in designing an effective and reliable SGCN Infrastructure.

Presenter: Efe Francis Orumwense received his B.Sc (Hons) degree from the School of Engineering, University of Benin, Benin City, Nigeria. He received his Master's and Doctorate degrees from the School of Electrical, Electronic and Computer Engineering, University of KwaZuluNatal, Durban, South Africa. He rejoined the University of Benin as a Lecturer in 2014.

He also worked as a lecturer and campuscoordinator at the Durban University of Technology, Durban, South Africa until 2019. Dr. Efe Orumwense is currently a Post-Doctoral Research Fellow at the Centre for Distributed Power and Electronic Systems (CDPES) at the Cape Peninsula University of Technology, Cape Town, South Africa. He has authored/co-authored a number of refereed peer-reviewed journal papers, books and conferences both nationally and internationally. He is also supervising postgraduate students in the field of communications. His research interest includes cognitive radio technology, energy efficient systems, network communications, smart grids, internet of things and engineering education.

BASIC COMPARISON OF THREE SUB-SAHARAN RENEWABLE ENERGY SECTORS UTILISING THE TRIPLE HELIX MODEL

Sub-Saharan Africa has an abundance of renewable energy potential, as well as the need for electrical power to grow these emerging economies. Yet these resources are very seldom exploited to their full potential.

This paper aims to do a basic comparison of three Sub-Saharan counties utilising the Triple Helix Model as tool, with the aim of identifying commonalities and differences, which could indicate where interventions can be applied. The status in South Africa is compared to the status in Kenya and Nigeria.

Presenter: S. Pietrangeli received the BTech and MTech degrees in Mechanical Engineering from the Central University of Technology, Free State and Cape Peninsula University of Technology, respectively. He specialises in the field of energy, specifically renewable energy and energy efficiency.

He is a founding member of the South African Renewable Energy Technology Centre and spent six years on the project in various roles, most notably the Operations Manager.

A SIMULATION STUDY OF NATURAL CONVECTION AIRFLOW PATTERN FOR A PHASE CHANGE MATERIAL CHAMBER

South Africa is the highest consumer of commercial energy per capita in Africa, ranking 16th in the world for primary energy consumption. It is also ranked among the bottom 50 of the 150 countries regarding energy efficiency, the cold chain is a large contributor. Refrigerated transport vehicles have played a major role in preserving goods over the years. With the current climate change, new refrigeration systems have been put in place to sustain this industry while complying with the changing climate regulations. This paper presents the use of Eutectic plates inside the refrigerated transport vehicle compartment.

This study numerically investigates the characteristics of phase change material (PCM) Eutectic plates applied at low-temperature ranges. To obtain a uniform heat transfer and airflow condition inside a refrigerated compartment, using the Reynolds stress model (RSM). A physical model and a mathematical model for three-dimensional (3D) transient natural flow were developed. Using the governing equation of mass, momentum and energy conservation, three Eutectic plate configurations were modeled and simulations in ANSYS Fluent to predict the temperature distribution and the velocity of the air flowing for 5 hours. The configuration with eutectic plates placed at the top and side showed great potential for the system. It had a high-temperature distribution across the compartment and promoted high air circulations compared to the other configurations.

Presenter: Thandiwe B. Radebe is a full-time student for MEng degree in Mechanical Engineering. He obtained his National Diploma and B-tech in Mechanical Engineering from the Vaal University of Technology.

TESTING AND PERFORMANCE EVALUATION OF A R404A TRANSPORT REFRIGERATION SYSTEM RETROFITTED WITH R290

R404A is a popular refrigerant used worldwide in medium to low refrigeration applications but due to its problematic environmental impact of high-GWP, there is an intention to completely phase it out. Thus this study investigated the performance of a low-GWP prospective refrigerant (R290) to substitute R404A. The main objective of this experimental study was to determine the thermal performance of a transport refrigeration unit retrofitted with R290. This study involved a one of kind testing facility at Tshwane University of Technology in order to achieve this objective. During the study the thermal performance of a low-GWP hydrocarbon refrigerant R290 was tested and compared to a high-GWP refrigerant R404A. The facility consists of a transport refrigeration unit designed to work on R404A.

Initially baseline tests were carried out using R404A and subsequently further tests were conducted on the system when retrofitted with R290 at various charge amounts and working conditions. The optimum charge was determined and the results indicate a significant charge reduction with R290. The refrigerating capacity is doubled at this optimum charge resulting in substantial improvement of the coefficient of performance (COP). These findings are particularly valuable considering no system modification was implemented.

Presenter: Maureen Ramaube is a researcher in the niche area of Applied Refrigeration and Thermal Energy Systems (ARTES) at Tshwane University of Technology (TUT). She is also a lecturer in the Department of Mechanical Engineering, Mechatronics and Industrial Design at (TUT), Pretoria. She holds a M-Tech degree in Mechanical Engineering from TUT

MODELLING & SIMULATION OF A DIRECT-EXPANSION SOLAR ASSISTED HEAT PUMP FOR WATER HEATING APPLICATION IN SOUTH AFRICA

Hot water heating accounts for about 7% of the energy demand in South Africa and about 30% in the residential sector. The most common heating method electrical resistance water heaters (geysers) are inherently fossil-fuel driven and thus responsible for carbon emissions. In this paper, the potential application of a direct -expansion solar-assisted heat pump water heater (DX-SAHPWH) system in South Africa was investigated. The DX-SAHPWH combines the beneficial characteristics of both the solar thermal collector and heat pump, however, the performance of a DX- SAHPWH system is significantly influenced by the changes in meteorological conditions.

A quasi-steady state mathematical model was developed and theoretical simulations were conducted using meteorological data of Cape Town. The results indicated an hourly average COP of was 4.9, collector efficiency of 50 %, solar fraction and heating times of 68 % and 192 minutes for average temperature, solar radiation and wind speeds of 23 °C , 700 W/ m2 and 3.3 m/s. The annual average COP was 5.3, collector efficiency 48 %, solar fraction 66% and heating time of 127 minutes. Furthermore, a parametric study indicated that the ambient temperature, solar radiation and wind speeds influence the system performance.

Presenter: Matthew Schouw holds a BTech Degree in Mechanical Engineering from the Cape Peninsula University of Technology .He is currently a Juniour lecturer and a Masters student in Energy and a Candidate Engineering Technolgist with ECSA .His current research interests include solar thermal water heating and solar integrated aquaponics systems.

ANALYSING DEMAND AND SUPPLY PROJECTS ON A MINE COMPRESSED AIR SYSTEM

The cost of electricity in South Africa has been increasing at rates that are significantly higher than inflation. Eskom most recently proposed increases of up to 15%. Various methods have already been introduced to reduce energy consumption at different types of mining operations. Efficient energy use has been and will continuously be a big focus going into the 4th industrial revolution (4IR). As found from literature, compressed air systems are one of the largest energy consumers at typical South African mines. This paper focusses on improvements on mine compressed air systems and limiting factors of reducing said energy consumption on an already optimized mine.

Through literature, it was found that specific energy can be used to analyse compressors. This method was used to characterise compressor systems and isolate areas where improvement projects may have a significant effect on a given mine's compressor energy consumption. The methods for proposing and implementing further projects are discussed with illustration thereof as well as the corresponding effects. Current initiatives, if sustained may result, in as much as R4.5 million per annum in energy savings. A properly analysed system combined with well-tailored, investigated and implemented projects can lead to further energy savings of up to R20 million per annum.

Presenter: William G. Shaw has a M.Eng in mechanical engineering and is currently busy with his PhD in mechanical engineering at CRCED Pretoria. He is currently a project engineer at ETA Operations, working mainly on compressed air system optimisation. In terms of research, he is interested in system optimisation, improved service delivery and the widespread effect of 4IR on people.

STRATEGIES FOR IMPROVING UTILITY SUSTAINABILITY

This presentation attempts to present the possible options for a hypothetical, illustrative electric utility facing challenges due to the impacts of renewables, the need for emission saving and pricing limitations.

In this context, the flexibility potential throughout an electricity utility system, from the demand side, supply side, network operations, storage as well as generation and others are covered. The concepts and applicability are universal.

Presenter: Karel Steyn

EFFICIENCY IN DISTRIBUTION NETWORKS WITH HARMONIC DISTORTION

Smart grids are reliable and easy to operate though it increases the challenges of harmonic distortion due to many electronic devices. Traditionally, harmonic distortion is neglected when efficiency in distribution networks is determined. They are usually calculated using fundamental frequency only. Efficiency of equipment and overall efficiency of the network is negatively affected by the harmonic distortion. Thus, this paper seeks to develop a methodology and new formulae for determining individual and overall efficiencies when harmonic distortion is present in a distribution network. The methodology and new formulae is developed using the directional active power flow. A radial distribution network with two harmonic sources (non-linear load and Solar Photovoltaic(PV)) and a capacitor bank is used for analysis. The method and case specific formulae are applied in this case study and results are generated. A harmonic filter is designed and implemented. It is indicated that the overall efficiency of the distribution network as well as the individual efficiency of the network is affected by the presence of harmonic distortion. Once the harmonic filter is implemented the overall efficiency of the network is improved significantly. The methodology and formulae has shown to be effective since it gives a better understanding of efficiency when distortion exist and its application is recommended for industrial use.

Presenter: Mrs. Rosalia Sinvula received the BTech and MTech (Cum Laude) degrees in electrical engineering from the Cape Peninsula University of Technology, Cape Town, in 2008 and 2010 respectively. Since August 2009, she has been an Inc. Engineer at Namibia Power Corporation (NamPower). In 2012 she was a part-time lecturer at the Namibia University of Science and Technology (NUST). Since 2013, she is a registered Inc. Engineer with the Engineering Council of Namibia (ECN). She is serving as a vice chairperson for the Namibia Women in Engineering as well as member of the following committees; AD-HOC Bid Evaluation Committee at NamPower; Integrated Management System Implementation Team at NamPower; and Program advisory board for the electrical and computer engineering department at NUST.

EXPERIMENTAL ASSESSMENT OF THE POTENTIAL DEMAND AND ENERGY REDUCTION BY RETROFITTING A BOILER WITH A COMMERCIAL AIR SOURCE HEAT PUMP AT A STUDENTS' RESIDENCE ON UNIVERSITY CAMPUS

Sanitary hot water consumption in the University residence contributes to a significant power and energy usage in relation to the energy consumed by other electrical devices. The study focused on retrofitting a 12kW boiler with two 1000 L storage tanks, with a 4.0 kW commercial air source heat pump (ASHP) unit to provide sanitary hot water at 55oC. A data acquisition system was built and employed in monitoring the operating performance of the electric boiler prior to intervention as well as operating performance of the ASHP water heater after the intervention. The results revealed that for the electric boiler, the average daily volume of hot water consumed was 1865 L, with an average power and energy consumption as well as load factor of 12.13 kW, 133.85 kWh and 0.464, respectively. In addition, the average daily volume of hot water consumed by the air source heat pump water heater was 1848 L while the average power, the average energy consumed and the load factor were 4.41 kW, 41.45 kWh and 0.370, respectively. We could conclude without reservation, that by retrofitting the electric boiler with a heat pump in a student residence (occupied by 75 female postgraduate students) on the University campus, an average daily energy saving of 94.40 kWh and a load factor reduction of 0.124 was realized while the average daily coefficient of performance was 3.10.

Presenter: Dr Stephen Tangwe is a postdoctoral research fellow at the department of Electrical, Electronic and Computer Engineering, faculty of Engineering Built Environment and Information Technology, Central University of Technology. He is a Chartered Engineer and a Member of the Institution of Mechanical Engineers (CEng MIMechE) and also a CMVP and an energy expert. He holds a PhD in Engineering from the University of Sunderland in the United Kingdom at the faculty of Technology, school of Engineering and Advanced Manufacturing. He also holds a Postgraduate Diploma in Renewable energy from Teri School of Advanced Studies in New Delhi, India.

AN APPRAISAL OF AN ARTIFICIAL NEURAL NETWORK MODEL TO PREDICT IMPROVEMENT OF GENERATING CAPACITY OF A COAL THERMAL POWER PLANT

Base load of the South Africa electricity supply utility (Eskom) is primarily generated from the coal thermal power plant. A scheduled routine maintenance is crucial in ensuring that each unit of the power plant continues to operate according to the manufacturer's specifications. The research focused on the analyses of "before and after" outage data obtained from the unit cards and power meters in one of the Eskom's "once-through" 600 MW coal boiler, with a mechanical conversion efficiency of 35%. The data set collected from the metering cards and also the power meters installed in the designated unit of the coal thermal power plant were divided into training, validation and testing data set of inputs; which included average air heater temperature, average main stream super-heater temperature, average high pressure and temperature heater temperature, the total mass of coal burnt, average of the cold and hot condenser well pressure and temperature and auxiliary power consumption) and the targets (power generated) both "before and after outage" scenarios. An artificial neural network model was developed to predict the desired output using the training data set. Furthermore, the model was validated and tested by the validation and test data set. The train neural network showed that the overall correlation coefficient of the outputs and targets for "before and after outage" was 0.979 and 0.992, respectively.

Presenter: Dr Stephen Tangwe is a postdoctoral research fellow at the department of Electrical, Electronic and Computer Engineering, faculty of Engineering Built Environment and Information Technology, Central University of Technology. He is a Chartered Engineer and a Member of the Institution of Mechanical Engineers (CEng MIMechE) and also a CMVP and an energy expert. He holds a PhD in Engineering from the University of Sunderland in the United Kingdom at the faculty of Technology, school of Engineering and Advanced Manufacturing. He also holds a Postgraduate Diploma in Renewable energy from Teri School of Advanced Studies in New Delhi, India.

AN ECONOMIC-COST ANALYSIS OF COMMERCIAL AIR SOURCE HEAT PUMP WATER HEATER IN THE UNIVERSITY CAMPUS

The implementation of energy efficiency intervention in the residence of the university campus can lead to a reduction in the electricity consumption and electricity bill. The study focused on retrofitting a 12 kW, electric boiler with two storage tanks of 1000 L capacity with a 4.0 kW air source heat pump (ASHP) unit, to provide sanitary hot water at 55oC. A data acquisition system was built and deployed in monitoring the baseline performance of the electric boiler and the actual performance of the retrofitted ASHP water heater. The results depicted that for the electric boiler, the annual energy consumed was 48858.21 kWh, while the annual energy consumed by the ASHP water heater was 14052.27 kWh, respectively. In addition, the annual energy saving due to the retrofitting with an air source heat pump unit was 34805.94 kWh.

The payback period of the ASHP unit was 1.7 years using the net present value of money with an Eskom tariff of R 1.50/kWh and an annual tariff hike of 15%, coupled with an annual rate of return of 6.5%. We could affirm that, by retrofitting the electric boiler with a heat pump in the student residence on the University of Fort Hare campus, there is a potential viability of the technology, since the payback period is well smaller than the life span (15 years) of the technology.

Presenter: Dr Stephen Tangwe is a Chartered Engineer and a Member of the Institution of Mechanical Engineers (CEng MIMechE) and also a CMVP and an energy expert. He holds a PhD in Engineering from the University of Sunderland in the United Kingdom at the faculty of Technology, school of Engineering and Advanced Manufacturing. He also holds a Postgraduate Diploma in Renewable energy from Teri School of Advanced Studies in New Delhi, India. He is an IEEE, AEE, SAEE and also an IEEE Power and Energy society member. He is an adhoc Eskom M&V Engineer with the UFH team. He is also a researcher in energy efficiency and a MATLAB application Engineer. He is a seasoned author and reviewer in accredited peer review Journals. Email: stangwe@ufh.ac.za; Tel: 0783076922

QUANTITATIVE ASSESSMENT OF THE PERFORMANCE IMPROVEMENT IN A COAL THERMAL POWER PLANT

A scheduled routine maintenance is crucial in optimizing a unit in a coal thermal power plant. The study focused on the diagnostic analyses of the “before and after” outage data obtained from the unit cards and power meters in one of the Eskom’s “once-through” 600 MW coal boiler power plant. The data set collected from the metering cards and the power meters installed in the designated unit of the coal thermal power plant (the main stream super-heater temperature, the mass of coal burnt, the auxiliary power consumed, the cold and hot well condenser temperature and the power generated) for the “before and after outage” scenarios were used to justified the improvement in the efficiency.

The results obtained from both scenarios showed that the average power generated and the average main stream superheater temperature was 474.46 MW and 476.29 oC for the “before outage" and 528.18 MW and 533.41 oC for the “after outage”. In addition, the heating rate (HR) of the unit in the coal thermal power plant “before and after outage” was 2.17 and 2.32 MWh/ton, respectively. Hence, we can conclude that after the energy efficiency intervention in the unit of the coal thermal power plant, there was an increase in the heating rate of 0.16 MWh/ton.

Presenter: Dr Stephen Tangwe is a Chartered Engineer and a Member of the Institution of Mechanical Engineers (CEng MIMechE) and also a CMVP and an energy expert. He holds a PhD in Engineering from the University of Sunderland in the United Kingdom at the faculty of Technology, school of Engineering and Advanced Manufacturing. He also holds a Postgraduate Diploma in Renewable energy from Teri School of Advanced Studies in New Delhi, India. He is an IEEE, AEE, SAEE and also an IEEE Power and Energy society member. He is an adhoc Eskom M&V Engineer with the UFH team. He is also a researcher in energy efficiency and a MATLAB application Engineer. He is a seasoned author and reviewer in accredited peer review Journals.

THE ECONOMIC FEASIBILITY STUDY OF RENEWABLE-BASED FUEL CELLS WITH GRID CONNECTION FOR A COMMERCIAL APPLICATION

Due to their high cost, limited life cycle, low efficiency, and restricted operating conditions, batteries may not be the most cost-effective method for large scale energy storage. On the other hand, hydrogen-based energy storage, such as in a microgrid system, is incessantly gaining more appreciation as a viable and sustainable alternative. This paper presents the economic feasibility study of renewable-based fuel cells with a grid connection for a commercial application. The Hybrid Optimization Model for Electric Renewable (HOMER Pro) software is used as a platform for simulation given the multidimensional nature in an optimization problem. The proposed model is constrained around financial and technical indicators. The optimal system architecture consists of high penetration of the solar photovoltaic system, a grid power, fuel cell generator, electrolyzer, hydrogen tank, and converter.

The Net Present Cost (NPC) is impacted directly by the sensitive analysis of the present and projected costs of components of the optimized system; also, the annual purchase capacity at the grid if scheduled rates option is considered. Considering a purchase capacity of 200 kW, the Photovoltaic system, fuel cells (FC), electrolyzer, hydrogen tank, and the converter are sized respectively for 311 kW, 200 kW, 200 kW, 400 kg and 243 kW. Therefore, resulting in an NPC value of $3 337 185,69; a Levelized Cost of Energy (COE) of $0,1095 per kWh and operating cost of $43 402,38 of the optimized system.

Presenter: Bruno P. Pougoue Tchintchui received a National Diploma and BTech degree in mechatronic engineering from the Cape Peninsula University of Technology in 2013 and 2014 respectively. From 2016 to 2018, he was a junior lecturer with the mechatronic engineering department at Cape Peninsula University of Technology Bellville campus. Since 2018, he has enrolled for an MTech with the Department of Electrical, Electronics and Computer Engineering, Cape Peninsula University of Technology Bellville campus.

BOILER HOUSE EXPANSION UNDER FLUCTUATING OFF-GAS AVAILABILITY

It is not uncommon for engineering plants to generate steam from excess burnable off-gases. These off-gases are typically by-products from plants throughout the engineering Works. Steam is utilised all over the Works in various processes. If excess steam is available after the Works' demands have been adhered to, energy recovery can processes can be invested in. A typical energy recovery plant comprises steam turbines for power generation. Depending on the nature of the process flows, the off-gas and steam availabilities may be of a fluctuating nature. This will inevitably result fluctuating power generation. This fluctuating power generation, however, may result in turbines shutting down involuntarily due to steam shortages.

This furthermore results in power generation losses due to unutilised steam. In an attempt to address and power generation losses and turbine trips, boiler expansion was investigated in this paper. Off-gas flaring was simulated and analysed to determine what flow quantities of steam the plant could potentially additionally generate. The steam flows were incorporated within a power generation optimisation model to simulate the true effect thereof. From the results it was demonstrated for the engineering Works that additional boiler houses can be invested in. The results showed increase power generation; however, further simulations showed that boiler expansions should be coupled to turbine investments to fully capture the energy recovery available for the Works.

Presenter: Dr. Philip Venter received his B.Sc. and B.Sc. Hons. in Actuarial science, B.Sc. Hons. Mathematics, B.Eng. and M.Eng. (Mechanical) and Ph.D. in Applied Mathematics from the North-West University (NWU) Potchefstroom. He is currently employed as a senior lecturer at the School of Industrial Engineering at the NWU. His research focus area is in thermal fluid simulations, with his main emphasis on mathematical and statistical modelling for system, control and investment optimisations. Before joining the NWU he worked as a Mechanical Engineer, gaining industry experience.

A PRACTICAL METHOD FOR COMPRESSED AIR LEAK LOCALISATION IN DEEP-LEVEL MINES

High electricity tariffs threaten the profitability of deep-level mining in South Africa. Industrial compressors are one of the largest electricity consuming systems on a typical deep-level mine. These compressed air systems are also known to be very energy inefficient. Numerous electricity cost saving initiatives have been implemented to reduce compressor electricity consumption on mines. These initiatives, however, predominantly focus on reducing the compressed air supply to match the demand. Matching the supply and demand of compressed air is limited to minimum pressure requirements of end-users.

Addressing the high underground demand, which can mainly be attributed to leaks, have been neglected due to the difficulty in identifying and quantifying underground inefficiencies. A new method has been developed to localise leaks to manageable areas in the vast underground compressed air system. In one of the case studies, the root cause of low compressed air pressure was found to be unregulated open-ended blowing pipes in the mining areas. It was estimated that conventional audits would have taken twice as long to identify these leaks. The removal of these and other unregulated air users resulted in an estimated annual electricity cost saving of R 1.4-million and increased the pressure for improved pneumatic equipment performance.

Presenter: Louis N. Zietsman holds a B.Eng. Degree in chemical engineering from the North-West University and a M.Eng. degree in mechanical engineering from the North-West University's Centre for Research and Continued Engineering Development (CRCED) in Pretoria.

CONTROL AND PROTECTION IN LOW VOLTAGE DC GRIDS

Many office applications are low power such as computers, monitors, laptops, phones and even LED lighting. Powering them from a 48 volt DC grid is sufficient and has one great advantage. Namely, the 48volt is safe regarding touching. However, protection to prevent excessive short circuit currents has to be provided. In this paper we discuss a 48 volt DC grid that is implemented as a living lab. In the living lab, droop control and short circuit protection are implemented.

The 48 volt DC grid is connected to a 350-400 volt DC grid via a bidirectional DCDC converter. The 350-400 volt DC grid is used for powering higher power levels such as air conditioning, battery storage, photovoltaic or an AC grid-tied inverter for power exchange. The theory behind and implementation of droop control, via a hybrid analog/digital controller is discussed along with measurements. Predictive short-circuit protection is discussed to prevent excessive short circuit currents. Earth leakage detection via monitoring is discussed as well as its advantage for DC grids. Droop control and protection are combined in a Grid Manager that regulates each load individually.

Presenter: Diëgo Zuidervliet holds a Bachelor degree in Electrical Engineering from The Hague University of Applied Sciences. He is presently a Research and Development Engineer at ATAG Benelux B.V. and a researcher at The Hague University of Applied Science. His research field is to transform AC household appliances from the firm ATAG into DC-Ready appliances. For example a working prototype of an induction hob working on 350Vdc.

SURNAME	NAME	CO AUTHOR	PG NO
Almaktoof	Ali	Ihmoumah;AA;Alaswad,MA	213
Balyan	Vipin	Groenewald,B;Khan Tal,M	113
Ben Hamad	Khlid	Kahn,MTE	198
Garcia	Felicidade	Raji,A	17
Gupta	Gunjan	Fritz,W;Kahn,MTE	247
Huan	Zhongjie	Ndanduleni,AUC	252
Ismail	Fareed	Gryzagoridis,J;Nemraoui,O;Schouw,M	234
Kaiser	Werner	den Heijer,W;Robbertse,W	275
Kaiser	Werner	Van Eldik,M	128
Mako	Itumeleng	Popoola,O	5
Mampuru	Madinoge	Kleingeld,M;Marais,J;Van Laar,J;Van Niekerk,S	36
Manyi-Loh	Christy	Tangwe,S	168
Markus	Elisha	Olatunbosun,A;Arogunjo,EO	122
Maroa	Semakula	Inambao,F	204
Mathews	Ian	Mathews,E;Van Laar,J;Hamer,W;Kleingeld,M	50
Mazimbo	Willard Ibrahim	Mapara,TS; Mhundwa,R; Matsan-gaise,TT	92
Meyers	Luyanda	Senda,P	23
Mhundwa	Russel	Simon,M;Tangwe,S	72
Murray	Billy		267
Mushiri	Tawanda	Marimbona,E	1
Mushiri	Tawanda	Tukuta,N;	28
Mutambudzi	Rufaro M	Raji,A	240
Nteka	Nambua	Kanyarusoke,K	43
Orumwense	Efe	Abo-Al-Ez,K	191

SURNAME	NAME	CO AUTHOR	PG NO
Pietrangeli	Sven	Wacht,A;Niemann,J;Schloesser,M;Fussenecker,C	10
Pougoue Tchintchui	Bruno Peguy	Raji,A	77
Radebe	Thandiwe Bongani	Huan,Z;Baloyi,J	260
Ramaube	Maureen	Huan,Z	183
Schouw	Matthew	Raji,A	176
Shaw	William	van Laar,J;Marais,J;Cillier,C;Stols,A;Mathews,E	98
Sinvula	Rosalia	Abo-al-ez,K; Kahn,MTE	137
Tangwe	Stephen	Manyi-Loh,C	145
Tangwe	Stephen	Manyi-Loh,C	152
Tangwe	Stephen	Manyi-Loh,C	160
van Ellewee	Werner	Kamanzi,J	55
van Laar	Jean	Mathews,G;Taljaard,JL;Vosloo,J;Mathews,E	105
Venter	Philip		220
Venter	Philip		283
Zietsman	Louis N	H.Johannes; Schoeman,W	86
Zuidervliet	Diëgo	Woudstra,J ; van Duijsen,P	65

Want to make your business more productive?

In business, you need to look at everything that can cost you revenue.

The Eskom Energy Advisory team is visiting customers/energy users nationwide - analysing their accounts, ensuring they are on the best tariff option for their operations. They are identifying and eliminating avoidable charges being levied. Their aim is simple…help you stay in business. Because when you stay in business, we stay in business.

The service is free of charge. It includes advice on how best to structure your energy load. You see, efficiency frees up energy capacity to improve your energy productivity in your business - expanding your operation.

Your advisor can guide you on the government's financial incentives, grants and tax rebates.

So contact your advisor today on email advisoryservice@eskom.co.za or visit www.eskom.co.za/idm.

Eskom | Powering your world