Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

ENGINEERING
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M&M Post-Graduate Topics

August 24, 2022

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Contents

Mr Johann Bredell

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- **Research Field**
  Structural analysis and design. Wind engineering.
- **General Description of Research Field**
  Structural analysis and design. Wind engineering. Solar tracking structures. Finite element analysis.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Experimental study of fatigue failure in photovoltaic modules and mounting structures Wind loads result in significant variable stresses in PV module structures. In addition, mechanical loads may cause reduction in power yield due to cracking of solar cells. This study aims to investigate the failure mechanisms in the solar cells, glass, frame, fasteners, and mounting rail. An experimental test rig must be developed to perform accelerated tests that are representative of wind loads. Structural simulation will form part of the design process. **Requirements:** FEM		✓		✓
Alternative structural designs for natural draft cooling towers The proposed topic forms part of a larger project in which the feasibility of using natural draft dry cooled steam condensers in thermal power plants is investigated. Dry cooled steam condenser systems are preferred over wet indirect systems due to their relatively high thermal efficiency and reduced environmental impact. Despite the virtues of natural draft dry cooled systems, traditional designs and construction methods make hyperbolic concrete towers prohibitively expensive. The aim is to investigate alternative structural designs for natural drafts cooling towers. Specifically, the feasibility of tensile membrane structures is of interest. A concept structure must be developed and compared to a traditional concrete structure. One of the metrics for comparison must be carbon footprint. **Requirements:** FEM		✓		✓
Proof of concept aluminium heliostat Traditional heliostat designs use glass as the reflective surface. Although glass has good optical performance, it has several disadvantages. This study aims to investigate the merit of using aluminium as the primary construction material for heliostats including the reflective surface. A practical structural concept must be developed that considers the shape of the mirror and distribution of stiffness. Wind loading considerations are of specific importance. Carbon footprint should also be used as a performance measure.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: FEM				
Experimental study of heliostat reflective losses due to wind loads The pointing accuracy of heliostats is adversely influenced by wind loads which will result in reduced performance in a solar thermal power plant. This study will investigate reflective losses using model-scale wind tunnel testing. The measurement of small angular deviations will form an important part of the study. The effect of various design parameters on pointing accuracy can be tested. **Requirements:** FEM		✓		✓

Dr Gareth Erfort
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- **Research Field**
  wind energy, CFD
- **General Description of Research Field**
  Open source CFD - extrnal aerodynamics Wind energy - resrouce assessment, small scale implementation, blade design and structural interactions

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Resrouce assessment sensitivity The student will use two packages to perform resource assessment. The one an open source package called Continuum and the other an industry std call WASP. The student must build a wind farm in both packages and compare the results. One of the biggest differences in these package is the data sets used. the student must reconcile the surface roughness maps used by each package and determine how influential these maps are in the AEP and CF estimates produced. If possible a real world wind farm will serve as the base case. **Requirements:** wind energy course		✓		
Renewbale energy database development Use Eskom supplied data to develop a dashboard on REIPPPP projects power output. Dashborad should break down power out to various farm operating. As the farm and Eskom will not provide this resolution the student must use WASA data to estimate farm performance and determine the % power each farm would theoretically provide **Requirements:** Coding based project - needs a strong background in handling datasets	✓			
Floating foundation development As South Africa looks offshore with unique water conditions require custom design for wind turbine floating foundations The student will investigate what makes our waters different from the locations currently hosting floating wind farms. They would then design a structure capable of handling these conditions using CFD and linear elastic models. The project will include field work and collaboration with multiple institutions **Requirements:** Structural mechanics (FEM) slow mechanics (CFD) numerical modelling experience			✓	✓

Prof Jaap Hoffmann
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- **Research Field**
  Solar thermal energy

- **General Description of Research Field**
  Solar thermal energy is a source of clean energy for electricity generation, process heat and thermal comfort that is unfortunately only available while the sun is shining. Thermal energy storage in rock beds using air as heat transfer fluid provides a low cost solution to store energy harvested during the day for night-time use. The large size of rock bed thermal energy storage, and irregular nature of crushed rock particles means that much of previous research done on prismatic beds of spherical particles is inadequate to describe pressure drop and heat transfer through packed beds. Hydrogen fuel cells and electric vehicles are the most promising substitutes for petrol and diesel driven vehicles in a post fossil fuel work. Hydrogen vehicles offer ranges and refueling times like those achieved by internal combustion engines. Hydrogen is a form of chemical energy that can be stored indefinitely. On the downside, hydrogen infrastructure is lagging that of electricity distribution. Overall, the outlook for hydrogen as a replacement for petrol and diesel in the transport sector is positive provided that it can be produced competitively. The copper-chlorine cycle as the most promising of all the thermochemical cycles for hydrogen production. In this cycle, water (steam) first reacts with CuCl2 to form HCl, and the HCl is then split into H2 and CuCl in an electrolyzer. Splitting HCl requires only about a third of the electricity input of that of splitting H2O. To facilitate the chemical reactions and recycle chemicals, the cycle requires several heat inputs at different temperatures. Some reactions are exothermic, and the heat released can be internally recycled to reduce the overall heat requirement of the cycle.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Green hydrogen via CSP pathways Evaluate the technology pathway(s) required, the current and future levelized cost of green hydrogen, and South Africa's potential for producing green hydrogen via the Cu-Cl cycle **Requirements:** Solar Thermal Energy Systems 814		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Solar hydrogen generation using the Cu-Cl cycle The Cu-Cl cycle was developed and demonstrated by Ontario Tech in Canada. This cycle requires a heat source (about 530 °C) and electricity. Both requirements can be met by a molten salt concentrated solar power (CSP) plant. The challenge is to find a suitable configuration of CSP plant to serve both high and low (100 °C) temperature heat exchangers - molten salts typically solidifies at about 250 °C. The student must develop, validate, and integrate working models of a CSP plant and the Cu-Cl cycle. The models (s) should be able to predict the shut-down procedure required when the CSP plant is running low on (stored) thermal energy. Several of these plants might be situated around South Africa where there are sufficient solar and (fresh) water resources to run the plant, and the necessary infrastructure to transport the product to a point of export/end use. Site selection forms part of the project, as well as the economic feasibility of the project. The student will spend 3 - 6 months at Ontario Tech. **Requirements:** Solar Thermal Energy Systems 814 A strong background in thermofluids will be advantageous.			✓	✓
Optimization of a packed bed thermal energy facility. Maximize bed utilization and minimize pumping cost for several discrete and continues design variables, such as number and size of inlets and outlets, bed length, bed height, particle size, etc. Since the flow is expected to be fully three dimensional, validated CFD model(s) of the bed (flow through porous media) is required. Existing models can be used/refined. The time scales for heat transfer and fluid flow is substantially different - the student must investigate ways to accommodate both in the same model, while keeping the simulation time down to levels that lend themselves to formal mathematical optimization. **Requirements:** Numerical Fluid Dynamics 414/814 or equivalent Advanced Design 814 or equivalent qualification in optimization A solid foundation in fluid dynamics and heat transfer will be advantageous		✓	✓	
Develop a low-cost passive condenser for a solar still A solar still using concentrated sunlight benefits from a small size and high evaporation rate. The high evaporation rate necessitates a condenser that can continually remove vapour from the still, and condense it into potable water. The application targets small rural communities, and robustness is key. A passive air-cooled condenser should fit the bill. The student should develop a model to predict the behaviour of such a condenser, and demonstrate it on laboratory scale. **Requirements:** CFD might be beneficial		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Solar still with a submerged absorber Interfacial evaporation in a solar still make effective use of the available sunlight as the bulk water remains cold, whilst evaporation happens only at the top of a membrane. The membrane wicks water to its upper surface. When using concentrated sunlight, the evaporation rate can exceed the transport rate of water through the membrane, leading tot dry-out. When this happens, evaporation stops. A submerged absorber can take advantage of a high surface temperature, whilst providing free access of water to the surface. The challenge is to develop a submerged membrane that mimics interfacial evaporation without any liquid flow restriction. **Requirements:** A solid background in undergraduate thermofluids subjects is required.	✓			
Turbulence modelling in porous media Flow through porous media is tortuous, and the presence of the solid matric causes additional turbulence production that is not present in flow through open channels. This turbulence helps to redistribute heat and momentum in a porous media. There are a few models in the literature to capture the extra turbulence production in the k-epsilon framework, but none (or few) for the k-omega turbulence models. Develop and validate (through the use of appropriate source terms) a model that can predict the extra turbulence dispersion in packed beds. Closure might be achieved on RANS, LES or DNS level. This project is expected to be mathematically intensive. **Requirements:** Numerical Fluid Dynamics 414/814 or equivalent		✓	✓	

Prof Craig McGregor
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- **Research Field**
  Solar thermal energy, green hydrogen
- **General Description of Research Field**
  Solar thermal Energy and Green Hydrogen research, focusing on:

  * techno-economic analysis * systems engineering and optimization * heliostat design and mechatronics * thermofluid design of solar receivers and thermal energy storage systems * industrial application of solar thermal heat * power cycle design for CSP and high temperature heat pumps

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
A review of recent CSP cost reductions through a technical and economic assessment of recent tariff price bids Concentrating solar power (CSP) has seen considerable cost reductions over the past decade, with installed costs having halved according to IRENA (2021). Given our excellent solar resources in South Africa, CSP offers an excellent opportunity to address our current electricity supply constraints whilst establishing a significant manufacturing industry in the country. This project will study the landscape of recent international CSP projects to model and review the causes of the cost trends over the past 5 years and to assess the implications for CSP technology deployment in South Africa. Technical and economic models of each of the recent CSP plants will be built in NREL's System Advisory Model and compared with published performance data on the plants. The economic model will be used to calculate the levelised cost of electricity and bid tariffs. The cost model must finally be fine-tuned to accurately predict the bid tariffs of the modelled projects. This cost model can then be used to forecast future cost trends for CSP in South Africa. **Requirements:** none	✓	✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Fuel-fired augmentation of CSP plants in South Africa as back-up for poor solar days Given our excellent solar resources in South Africa, concentrating solar power (CSP) offers an excellent opportunity to address our current electricity supply constraints whilst establishing a significant manufacturing industry in the country. Because a CSP plant includes a significant amount of thermal energy storage it can dispatch power throughout the night. Even in the desert locations such as the Karoo of the Northern Cape where CSP plants are located, there are periods of overcast or cloudy weather that would interrupt generation. A CSP plant that includes a fuel-fired system that would be able to continue generating electricity during periods of low solar resource, making CSP a firm and dependable power source. This project will study the technical and economic aspects of such a fuel-fired augmentation of CSP. The project should consider biomass and fossil fuel sources and investigate the best power cycle configuration (direct integration through the addition of a fuel-fired boiler, or an integrated solar combined cycle mode obtained by adding an open cycle gas turbine to the existing steam Rankine cycle of the CSP plant). **Requirements:** thermodynamics	✓	✓		
Design and configuration of solar thermal multi-tower field layout Central receiver CSP plants, also known as power towers, are built at very large scale (typically 50 to 100 MW or more). They require significant capital, and the 150- to 250-metre-tall tower can take up to two years to build. Conversely, utility photovoltaic (PV) plants can potentially be constructed within six months and require much less upfront capital. The intent of this project is to design and optimise a CSP plant composed of an array of heliostat field/tower modules (multi-tower system) that can be constructed quickly and sequentially, and that all supply a single power plant. Such a system has the potential to start generating electricity (and hence revenue) after completion of the first module of the array. The study will develop a simulation of the multi-tower including optical and thermal components, together with a cost model, will be used to optimise the configuration of the system. See e.g. https://doi.org/10.1063/5.0028916 **Requirements:** none		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Structural design and testing of advanced polygonal heliostat facets for advanced assembly line manufacturing A heliostat is a mirror assembly with dual-axis tracking that focuses solar irradiation on to the central receiver of a concentrating solar power (CSP) plant. Heliostats are high precision "robotics" systems that are costly to manufacture and constitute roughly 40% of the capital of a CSP plant, and a significant portion of the heliostat cost is the structure that supports and moves the aligned heliostat facets. Significant cost reductions in heliostat manufacture can possibly be achieved by applying a design for manufacturing approach on a novel heliostat facet sandwich structure and high reflectivity anodised aluminium sheeting, configured into a polygonal shape for increased optical and structural performance. The structural design, considering assembly line manufacturing, will be completed in the study followed by the fabrication of a large-scale facet for characterisation and testing. See e.g. http://dx.doi.org/10.1016/j.solener.2017.03.029 and https://doi.org/10.1063/1.5067066. **Requirements:** none		✓	✓	✓
Design and testing of a winch actuated heliostat A heliostat is a mirror assembly with dual-axis tracking that focuses solar irradiation on to the central receiver of a concentrating solar power (CSP) plant. Heliostats are high precision "robotics" systems that are costly to manufacture and constitute roughly 40% of the capital of a CSP plant, and a significant portion of the heliostat cost are the two actuators that perform the dual axis tracking of the sun. Typical commercial heliostats use worm drives for the azimuth drive and linear actuators with lead screws for the elevation drive. This study will design, build, and test a heliostat using a novel winch and cable actuation. See safeTrack H4™ - Trackers - Products - Ideematec safeTrack H4™ - Trackers - Products - Ideematec for a similar winch actuation concept applied to single-axis PV tracking. **Requirements:** good mechatronics topics, but suitable for mechanical stream students as well		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Thermofluid design and modelling of a thermosyphon liquid sodium receiver concept The central receiver is a critical component of a power tower concentrating solar thermal power system, cf. https://www.solarpaces.org/how-csp-works/. Solar energy is concentrated onto heat exchanger tubes in the receiver, where the heat is typically carried away by a heat transfer fluid such as molten nitrate salt or used to raise steam. The design of the receiver is complicated by the high temperatures and very heat fluxes (MW/m2) involved, and the need to make sure that the structural and material properties of the heat exchanger tubes of the receiver do not deteriorate. A novel concept using a loop thermosiphon (https://www.1-act.com/products/loop-thermosyphon/) has been proposed as an alternative to the conventional design. In the loop thermosyphon a working fluid evaporates to carry heat to a heat exchanger surface where is condenses, setting up a loop that can transport heat with no active pumping of the working fluid. The objective of this project is to develop a conceptual design and thermofluids model of a loop thermosyphon based solar receiver, using boiling liquid sodium metal as the working fluid. Students with a more practical inclination build and test a working prototype loop thermosyphon receiver that operates at a lower temperature, and that uses a safer working fluid. Co-supervised with Prof Ryno Laubscher. **Requirements:** CFD experience not required, would be an advantage		✓	✓	
Comparison of electrification of the South African Railroad network to the use of hydrogen fueled locomotives Railroad networks around the world have moved to electrification to eliminate greenhouse gas emissions. However, electrification of the networks involves the installation and maintenance of large systems of electric power distribution systems with the associated risk of restrictions on usage from vandalism or natural events. Traditionally, for many areas, the choice has been the usage of diesel fuelled locomotives over some or all the system. The South African rail system has challenges unique to this country. The limits of an economically justifiable electrified system should be investigated, and the economic analysis of hydrogen fuelled locomotives quantified. The use of hydrogen fuelled locomotives will require an entirely new infrastructure for production, storage, and distribution of the fuel. This fuel supply must be considered in the choice to use hydrogen fuel. As the development of this application proceeds, this supply question could determine its economic value to the user and to the transition to a sustainable energy system. Co-supervised with Dr Steve Clark. **Requirements:** none		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Exploitation of excess renewable generation Solar and wind generation are well known to be variable and dependent on weather rather than demand. Major usage of these resources requires overbuilding of the system to account for times when they do not meet the demand. The focus in designing these systems has been in meeting the times when they fail to meet the demand. Little effort has been expended in finding viable uses for the excess power that will be generated from these systems. Systems around the world are already faced with times where excess generation must be handled, leading to curtailment or negative prices. This situation will grow as the transition continues. Modelling indicates that this excess production could be over 30% of the overall energy generated with a system having generation completely from wind and solar resources, which in South Africa would be over 100 TWh of available energy annually. Any use of this excess energy must have the flexibility to use the energy when it is available with daily and seasonal variation. With little research and development in this area, there is a very large scope for innovation and open thinking in identifying and developing opportunities. Co-supervised with Dr Steve Clark. **Requirements:** none	✓	✓		

Prof Josua Meyer
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- **Research Field**
  Heat transfer

- **General Description of Research Field**
  Heat transfer conveys energy from a high temperature to a lower temperature. The mechanisms of heat transfer are defined as conduction, radiation and convective. In convective heat transfer the heat transfer might be external forced convection, internal forced convection, or natural convection. Heat transfer has many applications and happens everywhere.

  The human body is constantly generating and/or rejecting heat by metabolic processes and exchanged with the environment and among internal organs by conduction, convection, evaporation, and radiation. Heat transfer is also one of the most important factors to consider when designing household appliances such as a heating and air-conditioning system, refrigerator, freezer, water heater, personal computer, mobile phone, TV, etc.

  Heat transfer also occurs in many other applications such as in car radiators, solar collectors, orbiting satellites, etc. However, one of the most important applications is in the generation of electricity which can happen in fossil fuel power plants, nuclear power plants or concentrating solar plants. The heat transfer during the generation of electricity happens in heat exchangers which normally has at least one passage through which a fluid flows. The passage geometry can be as simple such as a circular tube or it can have a very complex geometry with fins that not only enhances the heat transfer but induces flow rotation which reduces the size of the heat exchanger.

  For all these configurations empirical correlations are required for design and analyses purposes that can be used to estimate heat transfer rates. To develop thousands of empirical equations are not desirable as we first need to have a better understanding of the fundamentals and flow phenomena. Furthermore, different flow regimes (laminar, transitional or turbulent) normally each require its own empirical equations. Thus, to be able to understand complex heat transfer flow phenomena in complex geometries we must first understand what happens in simple geometries, such as in circular tubes.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Developing flow in smooth circular horizontal tubes with a uniform wall temperature; forced and mixed convection. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. A lot of work has been conducted in the field of heat transfer in circular tubes. Most of this work was limited to forced convection flow through horizontal tubes, and with fully developed flow. Thus implying that the flow was both hydrodynamically and thermally fully developed. However, forced convection occurs very rarely in practical applications. It only occurs for heat transfer in small tube diameters, low heat fluxes and for flow in zero gravity conditions. Therefore, if the heat transfer condition does not satisfy forced convection conditions the heat transfer phenomena would definitely and most probably result in mixed convection. However, no work has been done for mixed convection with a uniform wall temperature during developing conditions. The purpose of this study would therefore be to numerically investigate and compare with CFD in a circular tube developing flow for forced and mixed convection with a uniform wall temperature. **Requirements:** CFD		✓	✓	✓
Local and average heat transfer coefficients for developing single-phase laminar flow in horizontal circular tubes with a constant heat flux boundary condition. Wide range of Prandtl numbers. Relevance: concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a constant heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, and as working fluids air and glycol. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications. **Requirements:** CFD		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Local and average heat transfer coefficients for developing single-phase laminar gas and glycol flow in horizontal circular tubes with a uniform temperature boundary condition. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a uniform heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, with air and glycol as working fluid. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications and were also developed for a constant heat flux boundary condition – not a uniform wall temperature. In this study a uniform heat flux needs to be used. **Requirements:** CFD		✓	✓	✓
Local and average heat transfer coefficients for developing single-phase laminar gas and glycol flow in horizontal circular tubes with a uniform heat flux boundary condition. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a constant heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, with and air and glycol as working fluid. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications and were also developed for a constant heat flux boundary condition – not a uniform wall temperature. In this study a uniform heat flux needs to be used. **Requirements:** CFD		✓	✓	✓

Dr Michael Owen
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- **Research Field**
  Heat transfer, thermodynamics, fluid mechanics
- **General Description of Research Field**
  Overall my research aims to contribute to sustainable production, use and manipulation of thermal energy. I make use of a combination of experimental, numerical (typically by means of CFD) and analytical methods to investigate thermodynamic cycles, thermal energy systems and components at a number of levels including high level feasibility analysis, system testing and analysis and component-level testing and simulation. There is a strong focus on industrial heat exchangers and cooling towers in particular (dry, wet and hybrid), as these systems directly affect thermal power plant efficiency (fossil-fuelled, nuclear and renewable) and have a direct influence on the energy/water nexus.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Investigation of module temperatures in floating solar photovoltaic arrays Floating solar photovoltaic (PV) power systems are being implemented as a means to generate power in a more efficient way. They have received attention internationally at large scale and have the potential to be implemented at multiple scales (e.g. on agricultural dams in South Africa). Installing PV arrays on still water bodies results in reduced module temperatures and associated increases in solar-to-electricity efficiency. Additional advantages include avoiding the need to utilize expensive land area and reducing water evaporation. PV power simulation software requires the input of heat dissipation factors to predict module temperatures and efficiencies during design and analysis simulations. These factors are typically only available for terrestrial open-rack configurations. Little research is available on what these factors are for floating applications. The purpose of the study will be to use a combination of experimental and numerical methods to model and quantify the thermal behaviour of a floating solar PV system. This will allow for specific heat dissipation factors to be derived which will support the accurate design and simulation of floating solar PV systems. This project will be co-supervised by myself, Dr Hannes Pretorius (M&M) and Dr Arnold Rix (E&E). (Note: this project has been allocated to a student for 2023.) **Requirements:** Students will benefit from a strong understanding of heat transfer and fluid dynamics fundamentals at undergraduate level. This topic will include both experimental and numerical work and may require use of CFD.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Solar-aided power generation in the South African context: "greening" our coal South Africa's energy supply is highly dependent on its fleet of coal-fired power plants, with over eighty percent of electricity demand being met with this fossil-fuel energy source. Considering that we will remain dependant on our coal power plants for several decades, the question arises as to how we can reduce the environmental footprint of our coal power or leverage the infrastructure at our coal stations to bring renewable energy online quickly and at lower cost? Solar-aided power generation (SAPG) is a hybridized approach in which solar thermal energy is incorporated into existing thermal power plants to improve the overall performance of the plant. Studies have considered using solar thermal heat for feedwater heating in coal-fired (Rankine cycle) plants to reduce the extraction of steam from the turbines for this purpose. In this way, the efficiency benefits of feedwater heating are realized while the steam flow through the turbines remains higher and thus (a) the turbine power output is greater for the same fuel consumption; or (b) the same power output can be achieved with lower fuel consumption. At the same time, the solar thermal energy is effectively converted to electricity but via the higher thermal efficiency of the coal-fired plant and at lower cost since it uses the existing power block and transmission infrastructure. Previous work on this topic at Stellenbosch University identified SAPG as an attractive option for the South African context. The work was however based on several simplifying assumptions and more work is required to better understand the techno-economic feasibility of this concept. This study aims to develop a more detailed thermodynamic model capable of simulating the performance of a SAPG plant under varying operating conditions (e.g. varying solar resource, ambient conditions and part load operation) and incorporating thermal energy storage. The study aims to answer the question of whether SAPG can and should be considered in South Africa. The project will be co-supervised by myself and Prof. Ryno Laubscher. **Requirements:** A strong grounding in fundamental heat transfer and thermodynamics at undergraduate level is required.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Athlone Power Station site redevelopment: a green energy hub for Cape Town The Athlone Power Station (APS) site is a 36 ha City-owned property that is located on the N2 freeway between the Cape Town Central Business District and the Cape Town International Airport. APS was a coal-fired power station (commissioned in 1962 and permanently terminated in 2003) and the site has recently been flagged for redevelopment into an innovative green energy utility site. Through the use of the APS site as a green energy utility and infrastructure site, the City of Cape Town intends to support economic growth and the provision of quality basic services. The site must contribute towards a cleaner, more affordable and reliable energy system that also responds to various interconnected social, environmental, and developmental priorities, for example, skills development, job creation and energy access. This project aims to investigate possible socio-technical innovations that demonstrate how different energy and industrial technologies can be combined to best meet these objectives. Attention may be given to the following points (amongst others): - Identifying which technologies best serve the primary energy targets of the development (120 MWe dispatchable generation); - Scoping various social, economic, environmental and developmental priorities from surrounding communities and the wider City of Cape Town to inform appropriate socio-technical options; - Identifying opportunities for alternative energy sources and technologies on site and how they can be integrated into local value chains to make a meaningful impact; - Evaluating how the site can be used to further promote and support green energy generation in and around Cape Town; - Conceptualizing how the site and technologies should be configured with concerns about visual, noise and air pollution in mind; - Evaluating how existing and legacy infrastructure (rail, road, waste, water, power evacuation, buildings) at the site can be utilised as part of an appropriate technical solution. This project will be co-supervised by myself and Dr Megan Davies from the Centre for Sustainability Transitions. **Requirements:** A sound understanding of energy systems and a willingness to tackle a multidisciplinary project is required.	✓	✓		✓

Dr Hannes Pretorius
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- **Research Field**
  Thermofluids & Solar Energy
- **General Description of Research Field**
  Dry cooling systems for power generation applications; Axial flow fan performance; Heat transfer analysis from PV panels; Floating solar PV power generation; Thermo-economic evaluation on CSP / PV power plants

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Investigation of module temperatures in floating solar photovoltaic arrays Floating solar photovoltaic (PV) power systems are being implemented as a means to generate power in a more efficient way. They have received attention internationally at large scale and have the potential to be implemented at multiple scales (e.g. on agricultural dams in South Africa). Installing PV arrays on still water bodies results in reduced module temperatures and associated increases in solar-to-electricity efficiency. Additional advantages include avoiding the need to utilize expensive land area and reducing water evaporation. PV power simulation software requires the input of heat dissipation factors to predict module temperatures and efficiencies during design and analysis simulations. These factors are typically only available for terrestrial open-rack configurations. Little research is available on what these factors are for floating applications. The purpose of the study will be to use a combination of experimental and numerical methods to model and quantify the thermal behaviour of a floating solar PV system. This will allow for specific heat dissipation factors to be derived which will support the accurate design and simulation of floating solar PV systems. This project will be co-supervised by myself, Dr Mike Owen (M&M) and Dr Arnold Rix (E&E). (Note: this project has been allocated to a student for 2023.) **Requirements:** Students will benefit from a strong understanding of heat transfer and fluid dynamics fundamentals at undergraduate level. This topic will include both experimental and numerical work and may require use of CFD.		✓		✓

Prof Johan van der Spuy
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- **Research Field**
  Turbomachinery
- **General Description of Research Field**
  1) The use of direct dry-cooling in power generation systems is a means of ensuring sustainable water usage. The efficient, low noise, operation of the axial flow fans that form part of such an air-cooled system is essential for a well-performing system. These research topics (topics 1, 2 and 3) focus on the design, testing and analysis of axial flow fans for these systems. 2) The use of micro gas turbines (MGTs) for the propulsion of aerial vehicles or solar thermal power applications hold specific advantages. The topic is related to the development of a turboshaft micro gas turbine.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
The development of a 30 kW turboshaft micro gas turbine. An existing project has developed the methodology for the design of a 30 kW turboshaft micro gas turbine. This project will continue this work by developing an actual gas turbine engine. Once completed, the engine will be tested and its performance verified. **Requirements:** CFD, thermofluids 344		✓		