MSc Dissertations Titles 2012/13

Supervisor Name: Ewen Macpherson

Project P001

Title:
Construction of dc-dc converter and PIC controlled inverter for wind turbine power take-off model

Short Description:
The aim of this project is to build a hardware system to create a laboratory model of a wind power system, to be used for undergraduate teaching. In previous student projects an inverter (controlled by a PIC) has been designed and partially constructed. This will require completing, and tested to allow the system to: (i) supply an isolated load, and (ii) supply power into the grid. A dc-dc converter to adjust the "turbine" variable dc output to supply the above inverter will also require designing and construction.

Type of project
Electrical system design and construction.

Necessary background for the project
First degree in Electrical Engineering, or attendance at semester 2 course "Power Conversion (MSc)"

Additional skills and expertise required for the project:
This project is suitable for someone good at making things work in the laboratory!

Project P002

Title:
Simulation of modular multi-level converters for HVDC systems

Short Description:
Modern HVDC links are increasingly using modular multi-level converters (MMC) at each end to convert the ac power to dc and vice-versa. This project will develop a software model of the MMC, which can subsequently (in another project) be used to examine the interaction of the MMC with the power network.

Type of project
Computer simulation of power electronic circuits.

Necessary background for the project
First degree in Electrical Engineering or attendance at semester 2 course "Power Conversion (MSc)"

Additional skills and expertise required for the project:

Project P003

Title:
Electric vehicle battery chargers that allow grid system support

Short Description:
With the rapid increase in wind energy systems, there is a need to provide short-term energy storage to match the variable wind energy resource to demand. There is considerable interest in using the batteries from electric vehicles to provide part of this storage. This project will examine the chargers/inverters that would be required to allow this, and the effect of this useage on the batteries.

Type of project
Dissertation, techno-economic evaluation of a technology.

Necessary background for the project
First degree in Electrical Engineering or attendance at semester 2 course "Power Conversion (MSc)"

Additional skills and expertise required for the project:

Project P004

Title:
Multi-terminal HVDC networks for urban environments

Short Description:
To date HVDC systems have been used almost exclusively for point-to-point bulk power transmission, such as the Cross-Channel link. With the new VSC HVDC technology, multi-terminal HVDC systems are now possible. This dissertation will examine the use of multi-terminal HVDC networks for urban environments

Type of project
Dissertation, techno-economic evaluation of a technology

Necessary background for the project
First degree in Electrical Engineering or attendance at semester 2 course "Power Conversion (MSc)"

Additional skills and expertise required for the project:

Supervisor Name: Ian Bryden

Project P005

Title: **Tidal Power Take-off Simulator for FloWave Tests**

Short Description:
The testing of 1/20th scale tidal energy models in the new FloWave test facility will require an accurate simulator for device take-off. You will develop such a concept, which allows inclusion of rotational speed control and measurement of torque and thrust.

Type of project (mechanical/electrical design)

Necessary background for the project (degree in Mechanical or equivalent)

Additional skills and expertise required for the project: MATLAB

Project P006

Title: **Bending Moments in Floating "Breakwaters/Attenuators/Absorbers"**

Short Description:
You will design a variable stiffness floating structure and investigate the relationships between bending moments and wave directionality using experiments and simple linear modelling techniques

Type of project (e.g. mechanical/electrical design)

Necessary background for the project (degree in Mechanical/Electrical/Electronics/Chemical engineering.):

Additional skills and expertise required for the project: MATLAB

Project P007

Title: **Slam Forces on Marine Systems**

Short Description:
You will investigate the parameters which influence the magnitude and duration of slam loads

Type of project (e.g. mechanical/electrical design and experimentation)

Necessary background for the project (i.e. degree in Mechanical/Electrical/Electronics)

Additional skills and expertise required for the project: MATLAB

Project P008

Title: **Tidal Energy Simulation in the Curved Tank**

Short Description:

You will need to design and hopefully build a simple system which can be installed in the curved basin to simulation at least some of the properties of a tidal flow for testing purposes.

Type of project (e.g. mechanical/electrical design, experimentation)

Necessary background for the project (experimental interest)

Project P009

Title: **The Tidal Energy Anomaly**

Short Description:
It can be shown mathematically that the speed of flow downstream from a tidal current system is greater than upstream. Demonstrate this counterintuitive process in the laboratory

Type of project (Experimental)

Necessary background for the project (experimental interest)

Additional skills and expertise required for the project:
MATLAB

Supervisor Name: John Chick

Project P010

Title: ***Carbon cost of building conservation measures in Edinburgh***

Short Description: Edinburgh council have been slow to double glazed windows in older buildings with some historical significance. This is applied in particular to listed building but also to non-listed buildings in conservation areas. In the later case, however, Edinburgh council have recently allowed for specific types of slim-line double glazing. It is not clear what the environmental impact of this action is. This project will divide Edinburgh into local areas, assuming various building types and usage, and develop simple thermal models of single glazed and double glazed buildings, and calculate the CO2 costs per year, and longer term implications of the Council's current strategy.

Type of project
Necessary background for the project: degree in Mechanical engineering
Additional skills and expertise required for the project:

Project P011

Title: ***Robust noise abatement strategies for small wind turbines***

Short Description: Noise from wind turbines is often been cited as one of the main objections to this form of renewable energy. Modern design and operating practices have reduced noise levels considerably. However, noise is still an issue. This project will investigate the current status of noise in wind turbine design and operation, and strategies to mitigate against unacceptable noise levels. Factors influencing small wind turbines (< 10kW) are quite different from larger machines The outcomes form this project will be a set of design strategies for noise reduction/acceptance of small wind turbines.

Type of project:
Necessary background for the project: degree in Mechanical engineering
Additional skills and expertise required for the project:

Project P012

Title: **Robust noise abatement strategies for large wind turbines**

Short Description: Noise from wind turbines is often been cited as one of the main objections to this form of renewable energy. Modern design and operating practices have reduced noise levels considerably. However, noise is still an issue. This project will investigate the current status of noise in wind turbine design and operation, and strategies to mitigate against unacceptable noise levels. For example, noise generation from the trailing edge of the blade is one of the principle sources but can be minimised in several ways: making the trailing edge as thin as possible, or by

introducing serrations or feathering along the trailing edge. Such strategies may be effective in the short term but may impact on the robustness of the machine. The outcomes form this project will be a set of design strategies for noise reduction which consider the overall performance of the machine over its lifetime.

Type of project
Necessary background for the project: degree in Mechanical engineering
Additional skills and expertise required for the project:

Project P013

Title: ***Electric Vehicles and a Business Plan with Numbers***

Short Description: The project is to perform a feasibility study for electric vehicles charged from micro-renewable energy sources in various climates. With increasing petrol prices the market for electric vehicles is opening up. What sorts of limitations are there if the vehicles are to be charged from micro-renewable systems? A number of products are already available.
This project is to design a complete working system or number of systems from off-the-shelf components. Develop a product plan and perform an economic, carbon and energy life cycle analysis. Questions to be answered are: Is it green? Is it economically viable? Are electric vehicles user-friendly? How do the answers to these questions depend on the local the climate etc? Take the answers for these questions and develop a business plan and product sales pitch.

Type of project (e.g. mechanical/electrical design, computer simulation, analytical study, dissertation, techno-economic evaluation of a technology etc)

Necessary background for the project: degree in Mechanical engineering

Additional skills and expertise required for the project:

Project P014

Title: ***Impact of the rise of wood burning stoves in the UK***

Short Description:

It has recently been reported that there is a surge in the popularity of wood burning stoves for domestic use in Scotland. The consequences and sustainability if this are not clear. This project investigates the impact and sustainability of large numbers of domestic wood burning stoves, and in addition to the obvious greenhouse emissions, may also include wider health implications.

Necessary background for the project: degree in Mechanical engineering

Additional skills and expertise required for the project:

Supervisor Name: Markus Mueller

Project P015

Title: Electrical Generators for Oscillating Water Columns

Short Description: Most OWCs use an induction generator, but there are number of other generator types that could be of benefit: eg. switched reluctance generator or a permanent magnet generator. In this project you will review the different types of generator and complete designs of each type for an OWC. A spec will be provided for the project.

Type of project mechanical/electrical design, computer simulation

Necessary background for the project Mechanical/Electrical/
Additional skills and expertise required for the project:

Project P016

Title: Switched Reluctance Generator for Direct Drive Wind Turbines

Short Description: The switched reluctance generator is a very robust electrical machine. It requires no magnet material, which is a bonus given the increasing cost of permanent magnet material. Recent research from Newcastle University has shown a novel switched reluctance technology with a higher torque density than conventional switched reluctance machines. Work at Newcastle has focussed on small machines for automotive and industrial applications. In this project you will investigate the feasibility of applying this technology for direct drive wind turbines.

Type of project. mechanical/electrical design, computer simulation
Necessary background for the project degree in Mechanical/Electrical
Additional skills and expertise required for the project:

Project P017

Title: Low Cost Permanent Magnet Generator for Direct Drive Wind Turbines

Short Description: Most wind turbine developers are using rare earth based permanent magnet materials in their generator designs. However, the cost of these materials has increased ten times in the last 24 months. Ferrite magnets are significantly cheaper than rare earth based materials. In this project you will investigate a permanent magnet generator design utilising ferrite magnets in order to reduce the capital cost of the generator.

Type of project mechanical/electrical design, computer simulation, analytical study

Necessary background for the project degree in Mechanical/Electrical
Additional skills and expertise required for the project:

Project P018

Title: Reliability of Electrical Generators in Renewable Energy Applications -

Short Description: Electrical Generators and power converters cause the greatest number of faults in wind turbines. Reliability analysis will be performed on electrical machines for offshore renewable energy applications, and using the results from this analysis you will investigate the design of particular components to improve reliability.

Type of project mechanical/electrical design, computer simulation, analytical study,
Necessary background for the project degree in Mechanical/Electrical/Electronics/
Additional skills and expertise required for the project:

Project P019

Title: Multi-Body Modelling of Drivetrains in Renewable Energy Applications -

Short Description: Drivetrains account for the majority of failures in offshore wind turbines. Wind loadings from the turbine result in misalignment within the drivetrain, which impact on bearing wear and tooth wear in the gearbox. IES has recently bought SIMPACK, software for drivetrain modelling. In this project you will use this software to investigate the movement of the various components within the drivetrain due operational loads from the prime mover as well as the generator. The results from this work will feed into PhD research on reliability of electrical generators, in particular on bearing failures.

Type of project mechanical/electrical design, computer simulation, analytical study,
Necessary background for the project degree in Mechanical/Electrical/Electronics/
Additional skills and expertise required for the project:

Project P020

Title: Fully flooded linear generator for direct drive wave energy converters-

Short Description: Sealing a linear generator in a wave energy converter is challenging. Allowing the generator to operate fully flooded could lead to improved thermal properties of the generator. However, corrosion becomes an issue. In this project the student will investigate the feasibility of fully flooded operation, in particular what materials and coatings are required to reduce corrosion, and the thermal performance of the machine. This project follows on from a previous MEng project, in which a test rig was developed to measure the heat transfer characteristics of flooded generator coils.

Type of project mechanical/electrical design, computer simulation, analytical study,
Necessary background for the project degree in Mechanical/Electrical/Electronics/
Additional skills and expertise required for the project:

Supervisor Name: David Forehand

Project P021

Title:

Influence of Rigid Support Structures on the Performance of Wave Energy Converters

Short Description:

Concepts for Wave Energy Converters (WECs) come in many different forms. Many of these forms can be grouped into the following classes: point absorbers or buoys; attenuators (which are oriented parallel to the principal wave direction); terminators (which are oriented perpendicular to the principal wave direction); oscillating water columns and overtopping devices.

Another important way to classify some WECs is to specify the source of reaction. That is, the power take-off (PTO) module needs something to react against in order to absorb power from the waves. For example, in the Pelamis wave energy device the PTO reacts (or the PTOs react) against other parts or sections of the machine. In other words, Pelamis uses the relative motion between the sections of the device in order to extract power.

For near-shore or relatively shallow water devices, it is possible to react against a rigid support structure. Examples of this include the Wavestar device (http://wavestarenergy.com/) and the Wave Treader concept (http://www.power-technology.com/projects/greenoceanenergywav/). In their simplest form, both of these can be considered to be a series of heaving (i.e. vertically moving) buoys that are attached and oscillating close to a rigid, vertical, cylindrical support structure. When an incident sea wave hits this support structure it will be diffracted and scattered by it. Thus the buoys will experience a slightly different wave climate from the case when the support structure is not there.

This project will be a numerical project in which you will use the computer code WAMIT to determine what influence the presence of the supporting vertical column has on the power produced by the heaving buoys. Training in how to use WAMIT will be given.

Type of project: Computer programming/simulation.

Necessary background for the project: degree in Mechanical/Civil Engineering (or Physics/Mathematics).

Additional skills and expertise required for the project: Some previous exposure to computer programming in the past is essential (ideally Matlab programming but other similar programming languages would also be acceptable). A willingness to learn some Matlab programming is also necessary, as is a reasonable level of mathematical ability.

Project P022

Title: Modelling Nonlinear Forces on Wave Energy Converters

Short Description:

In order to predict the power generated by a floating Wave Energy Converter (WEC) it is necessary to model its motion in waves. This in turn requires the modelling of the various forces acting on the WEC. In addition to the forces on the WEC due to its Power Take-Off (PTO) mechanism and any mooring forces, the WEC will also experience forces due to its interaction with the water. These interaction forces include the wave excitation force, the hydrostatic buoyancy force and the radiation force (which is due to the fact that the WEC will be radiating out waves because of its motion). Traditionally, these forces are modelled using linear theory (i.e. assuming small waves and small body motions) but this approach may not be accurate enough to correctly model the problem.

In this project you will do some computer modelling to calculate more accurate nonlinear versions of the wave excitation force and the hydrostatic buoyancy force. You will then simulate the motion of the WEC in waves using these nonlinear forces and compare the results with those when only linear forces are taken into account. This topic will be very useful for current research into the performance of wave energy converters.

Type of project: Computer programming/simulation.

Necessary background for the project: degree in Mechanical/Civil Engineering (or Physics/Mathematics).

Additional skills and expertise required for the project: Some previous exposure to computer programming in the past is essential (ideally Matlab programming but other similar programming languages would also be acceptable). A willingness to learn some Matlab programming is also necessary, as is a good level of mathematical ability.

Supervisor Name: Henry Jeffrey

Project P023

OTEC - Offshore Renewables Multipurpose Platform Feasibility Study.

The topic of marine energy has been identified as a promising field, especially the production of energy using multi-Renewable Energy Platforms. This raises the question to what extent combinations of different energy sources such as wind, wave, ocean currents, tidal, solar and water temperature differences (OTEC – Ocean Thermal Energy Conversion) are reasonable and economically viable in the future.

Questions - What questions should answer the study?
• What is a suitable combination of several (minimum two) renewable energy generation techniques together on a possible platform to achieve synergies compared to their individual systems? What are these percentages?
• What costs can be expected per kWh?
• What share (in MW) of the world's electrical needs could in 10, 20 and 50 years be covered assuming the expected economic effects of multi-Renewable Energy Platforms and where?
• What share (in MW) of the world's electrical needs could in 10, 20 and 50 years expected to be economically viable due to multi-Renewable Energy Platforms of type 1 (see below) covered?

Contents of the Study:
Taking into account the seasonal variability of the various renewable resources a pre-selection of global sites will be done in order to ensure the use of different multi-Renewable-Platforms. The pre-selected sites are to be representative for many locations worldwide; they should not be any special or extreme cases. From this preliminary selection three sites will be investigated in greater detail. For the three sites it is expected that the approach will lead to different solutions.
Based on existing data and studies for each location a plausible concept for a multiple platform is to demonstrate, taking into account:

- **Installation cost**
- **Service and maintenance**
- **Grid connection requirements**
- **lifetime Views**
- **potential savings compared to individual types of energy production**

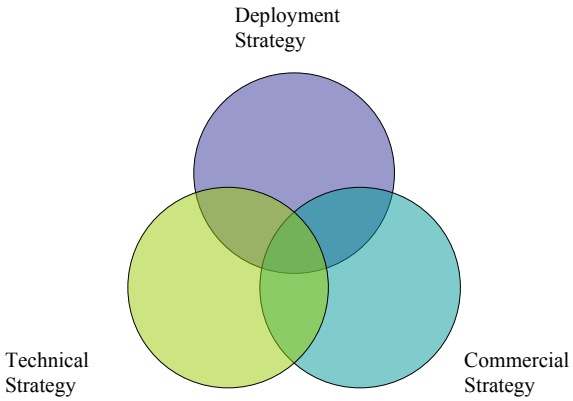
For each of the three platforms (types 1, 2 and 3) the cost per kWh shall be determined or estimated, if possible via a separate consideration of installation, operation, and maintenance costs.

Project P024

Technical and Commercial Strategy for the deployment and exploitation of multi-use marine platforms

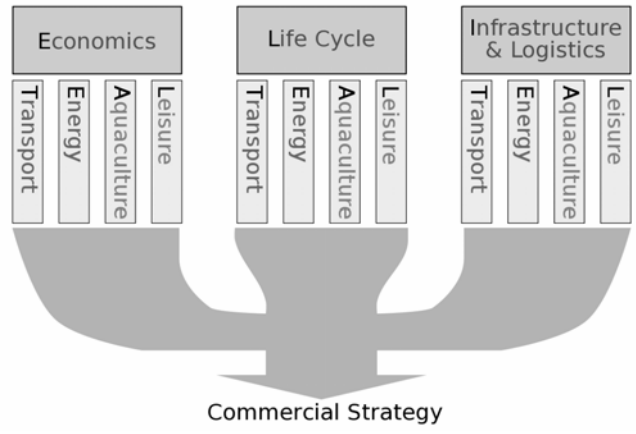
This project will develop an overall deployment strategy for a multi-use platform system in order to ensure that there is a coherent and coordinated forward strategy for concepts developed. This will be carried out with close liaison technical needs, by building upon the possible service module functions (transport, energy, aquaculture and leisure) and the geographical locations identified in previous studies. There will also be close ties with the engineering design and the integration design work.

The overall deployment strategy for the multi-use platform system will be built upon both a technical strategy and a commercial strategy. The Deployment Strategy will identify the timelines for pilot scale systems through to the deployment of full scale demonstration and established projects.



The Technical Strategy will be assembled from existing material from sector roadmaps which will identify the technical advancements and opportunities associated with the development of multi-use platform systems.

The Commercial Strategy will be fully developed through a series of ELI tasks (Economics, Life-cycle assessment, Infrastructure and logistics) as shown visually below. Each of the tasks will utilize the TEAL approach (Transport, Energy, Aquaculture and Leisure) in order to ensure that each tasks gives appropriate consideration of the wide range of different functions possible to combine on the multi-use platform system.



Developing the Commercial Strategy and Formulating a Deployment Strategy:

This overall project will analyze the integration of the different service modules and the synergies and commonalities that arise in the whole system in order to develop a commercial strategy for the multi-use platform system developed.

The task will produce a set of actions and policy recommendations based on the lessons learned from analyzing the regional case studies in terms of economics, life-cycle assessment and infrastructure and logistics. It will provide advice on topics such as capacity building and planning through to market assessment and policy design.

Supervisor Name: Colin Anderson

Project P025

Title: Economic comparison of shale gas and onshore wind for UK electricity supply

Short Description: Shale gas, obtained by hydraulic fracturing or 'fracking', now contributes substantially to energy supply in the US and is increasingly being proposed as a bulk source of gas for UK electricity production. This project will involve detailed analysis of the economics of shale gas for UK electricity supply, and direct comparison with onshore wind energy. The project will involve a combination of desktop research, interviews and information gathering from industry sources for both energy types, and detailed analysis of each technology and its associated costs. The aim is to produce a balanced and objective report based on strong source material.

Type of project Analytical study including desktop and external research and interviews, plus economic modelling.
Necessary background for the project Engineering or Science degree, with some background in economics.
Additional skills and expertise required for the project: Good analytic skills are required in order to draw objective conclusions from a wide variety of economic and technical data. Student must be comfortable interviewing industrial and academic sources, including owners and operators of wind energy developments, and experts in the oil and gas sector. Some travel will be required, mostly within Scotland.

Project P026

Title: Investigation of wake interaction losses for a real windfarm

Short Description: Wake interactions in windfarms lead to a reduction in overall energy capture, and increased turbulence on downwind machines. These effects are modelled in most modern windfarm design codes, but the results are not always compared with the practical outcome once a windfarm is built. In this project measurements will be analysed from a linear array of three wind turbines in order to extract directional wake characteristics, and compare them with theoretical models. Wake characteristics will be analysed in regard to both energy loss and turbulence intensity.

Type of project Analytical/theoretical study based on real measurements, and review of theoretical HAWT wake models.
Necessary background for the project Engineering or Physics, including aerodynamics and/or fluid dynamics.
Additional skills and expertise required for the project: An ability to process large experimental data sets (and familiarity with Excel) to extract key results is required. A practical understanding of wind turbine aerodynamics is needed. A short site visit will be included.

Supervisor Name: Gareth Harrison

Project P027

Title: Creating Long-Term High Resolution Wind Power Hindcasts

Short Description:

Recent work in the School of Engineering has developed unique and highly sophisticated models of the UK and Irish wind resources. The models do an excellent job in representing hourly time series at a 3km resolution over ten years. A full understanding of wind climate requires a longer time series but this would be expensive as the analysis developed by the School required a supercomputer. The project aims to develop a longer wind time series using statistical modelling to relate the School's high resolution dataset to the lower resolution assimilated weather data used to create it.

Type of project: statistical study and computer simulation

Necessary background for the project: numerical degree

Additional skills and expertise required for the project: The project is suitable for those with strong interest in wind power and meteorology, excellent knowledge of statistics and good programming experience in Matlab.

Project P028

Title: Performance of a Mesoscale Weather Model in Hindcasting Energy Demand

Short Description:

The Institute has in recent years been using a sophisticated numerical weather forecasting model to hindcast wind speeds over the UK and Ireland. It provides hourly wind speed information at 3km resolution and does a very good job at representing historic wind speeds. Many other weather variables such as rainfall, temperature, humidity, insolation, etc., were archived and are intended for use in simulating other aspects of energy generation, transmission and consumption. This project will conduct a study of how well this high resolution dataset performs against existing Met Office measurements and in estimating electricity demand across the UK.

Type of project: computer and analytical study, statistical analysis

Necessary background for the project: numerate degree

Additional skills and expertise required for the project: This project will need a good understanding of statistics and some skill in handling quite large datasets. Knowledge of Matlab or similar programming language is necessary.

Project P029

Title: Full Life Cycle Assessment of Tidal Current Turbine

Short Description: Earlier research within the Institute developed a pioneering carbon and energy audit of Seagen a tidal current turbine (Douglas et al., 2008). It was based on a detailed assessment of the materials use across the life cycle of the device. This project will extend the analysis to a full life cycle assessment to capture a broader range of environmental impacts and alternative means of deploying the device.

Type of project: life cycle assessment
Necessary background for the project: none
Additional skills and expertise required for the project: This project will require a good skills with excel and the desire to become fully conversant with LCA techniques.

Project P030

Title: Measuring the Benefits of Smart Grid Control

Short Description: Research within the Institute is developing new ways of understanding how to connect more renewable generation in electricity networks through the use of 'smart' control of distribution networks. The project will develop a method to understand the effect of smart grid controls on distribution network planning schedules using an optimisation approach. This project requires a good understanding of power systems and some programming expertise.

Type of project: power systems optimisation/computer simulation
Necessary background for the project: electrical power, maths, physics
Additional skills and expertise required for the project: This project requires a good understanding of power systems, excellent maths and some programming and optimisation expertise (although our software development environment makes the creation of optimisation tools relatively easy).

Project P031

Title: Rehabilitating Scotland's weirs for hydropower generation

Short Description: The School has recently completed work modelling the opportunities for new hydropower schemes in Scotland. The work neglected to consider the rehabilitation of existing weirs and this project will undertake that work. It will make full use of Ordnance Survey tools and new hydrological models to assess the scope for using weirs for hydro generation.

Type of project: GIS/computer simulation
Necessary background for the project:
Additional skills and expertise required for the project: The project is suitable for those with strong interest in hydropower and ideally some experience with Geographical Information Systems (GIS).

Supervisor Name: Aristides Kiprakis

Project P032

Title: Solar Thermal vs. Photovoltaic Energy Conversion for Buildings: A Comparative Cost/Benefit Analysis

Short Description: Solar energy is one of the most accessible renewable energy technologies. Its applications range from large power stations down to small installations integrated in domestic and commercial buildings. At building level, the main technologies used are solar thermal systems and photovoltaic arrays. Each of the two has its own characteristics in terms of efficiency, economics and they need to be matched to the demand of heat and electricity by the building and its users.

This project will evaluate the technologies for solar thermal and photovoltaic conversion available at the domestic/building scale and will compare their performance in terms of cost and energy efficiency, taking into account the local climate, the building energy demand and the economics at various locations in the world. The goal of the project will be to define an algorithm for the selection of the optimal mix of thermal and photovoltaic utilisation of solar energy.

Type of project: Dissertation, techno-economic evaluation of solar energy conversion technologies)

Necessary background for the project: None. All students are eligible for this project. **However it is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: Good analytical and numerical skills, excellent knowledge of Matlab and/or Excel.

Project P033

Title: Optimal Prioritisation of Energy Efficiency Measures in the Domestic and Small Commercial Sectors

Short Description: It is well known that investment in demand-side energy efficiency measures is the most effective means of improving the overall efficiency of the energy supply chain. There is a long list of technologies that can be used in order to make the energy consumption of a domestic, institutional or small commercial building more efficient, such as heat insulation, efficient electrical devices/appliances, use of renewable energies etc.; each of these technologies has its own characteristics in terms of cost and efficiency improvement. Their availability and performance is also related to the location of the building. There are many studies that illustrate the applicability and the result of using such technologies, but most of them assume an unconstrained budget.

This project will make a comparative assessment of the available energy efficiency technologies at various locations and will devise an algorithm for the optimal implementation of them, within a constrained budget.

Type of project: Dissertation, techno-economic evaluation of energy efficiency technologies)

Necessary background for the project: None. All students are eligible for this project. **However it is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: Good analytical and numerical skills, excellent knowledge of Matlab and/or Excel.

Project P034

Title: Development of an Electrical Load Categorisation System Based on Artificial Intelligence

Short Description: In the UK and abroad, a rollout of smart meters is under way. The smart meters are collecting high resolution energy consumption data from the customers and then send them in raw format to the supplier for processing. Based on this information, the supplier is then able to do billing, to offer bespoke energy tariffs that match to the consumers' profiles, and to perform demand side management. However, there are some significant issues with regard to security, privacy as well as volume of data that need to be transmitted. As an alternative, some pre-processing could be done by a smart "-er" meter before the data are transmitted to the supplier. The pre-processing could place the customer in a pre-defined category based on his energy use profile, and the supplier could then make decisions based on this abstracted information, thus reducing the amount of information need to be transmitted and eliminating the privacy and security issues.

The goal of this project is to develop a sorting algorithm using artificial intelligence techniques, and then develop a smart meter using a single-board computer (such as the Raspberry Pi) that will be able to perform the above processing in real-time.

Type of project Electronics design, programming, analytical study

Necessary background for the project: Strictly an Electronics/Electrical/Computer Engineering degree. **It is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: The student should be able to quickly develop (or already possess) good knowledge on Artificial Intelligence techniques (e.g. fuzzy logic, artificial neural networks). Excellent programming skills are required. The student should also have significant experience in developing electronics systems.

Project P035

Title: Options for and Benefits from Demand Side Management in an Isolated Island Power System

Short Description: The benefits of the application of Demand Side Management in a power system have been intensively studied during the past years and DSM technologies are now being applied in many countries. It is expected that the impact of DSM on the operation of an isolated power system with limited generation capacity and large load variations will be even more dramatic.

This project will study the available DSM measures that can be utilised in relatively small isolated power systems and will quantify their benefits. As a case study, the isolated power system of the Greek island of Crete will be analysed. Crete has an installed capacity of around 700MW and a load that varies widely between winter and summer due to highly developed the tourism industry of the island. The electrical load characteristics of the island will be studied and a DSM strategy will then be proposed.

Type of project Power system modelling and analysis

Necessary background for the project: Strictly an Electronics/Electrical Engineering degree. **It is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: Good analytical and numerical skills, excellent knowledge of Matlab and/or PowerWorld or PSS/E.

Project P036

Title: Energy Storage Options for Offshore Renewables

Short Description: In recent years, offshore renewables have received lots of attention both in terms of research and actual project implementations, with the reason being the magnitude and the continuous availability of the resource. New technologies such as wave energy converters and tidal current turbines have also emerged and some of them have already reached the commercial stage. One of the greatest disadvantages of offshore renewables (as well as their onshore counterparts) is the difficulty in scheduling them, due to the variability of the resource. A solution could be the development of large-scale energy storage facilities. Technologies such as pumped storage, hydrogen generation and flywheels have been proposed, and all of them have their individual characteristics.

This project will assess the proposed energy storage technologies and evaluate their applicability to offshore renewable energy conversion. Particular focus will be given to offshore pump storage as a potential storage technology. A Matlab/Simulink model will be developed and a feasibility study that will match it with the various offshore renewable energies (wind, wave, tidal) will be performed.

Type of project Analytical study, computer modelling & simulation

Necessary background for the project: Strictly an Electrical/Mechanical Engineering degree. **It is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: Good analytical and numerical skills, excellent knowledge of Matlab/Simulink.

Project P037

Title: Water-to-Wire Modelling of a Small Tidal Current Turbine

Short Description: Tidal current energy conversion is one of the most promising renewable technologies due to its predictability and the relative straight forward conversion process. There are many developers that have systems at stages very close to commercial. While economies of scale dictate that a larger tidal current turbine will be more profitable than a smaller one, there is a second school of thought, which claims that multiple smaller devices will be more reliable in the long term as a fault will affect only one of them, while the rest will keep generating. With the short windows of opportunity for maintenance in the offshore environment, this may mean that a farm design with many smaller turbines may be favoured against a design with fewer, larger devices as the overall farm availability and reliability will be higher.
This project involves modelling of an existing small scale tidal current turbine, developed by an Edinburgh-based company. The model will be created in Matlab/Simulink using data provided by the developer and its overall performance will be compared with larger devices.

Type of project Computer modelling and simulation of a tidal current turbine.

Necessary background for the project: Strictly an Electrical/Mechanical Engineering degree. **It is an absolute requirement that any interested students should meet the supervisor to discuss the details prior to selecting the project. DO NOT pick this subject unless you have met with Dr Kiprakis.**

Additional skills and expertise required for the project: Good analytical and numerical skills, excellent knowledge of Matlab/Simulink.

Supervisor Name: Lucy Cradden

Project P038 (Co-supervised with Dougal Burnett)

Title: Investigating the potential impacts of climate change on thermal power plant

Short Description:
The aim of this project is to understand the potential effects of increasing temperatures on thermal power plant operation. Ambient temperatures are expected to rise over the coming decades, which would be expected to impact negatively on thermal power generation, particularly at times of maximum temperature. This will be particularly problematic if the UK continues to depend heavily on thermal power generation, and if a trend for using air-conditioning in hot weather were to become the cultural norm. The first part of the work will involve extensive literature review of other studies in this area, and an investigation of suitable modelling techniques. Using an appropriate method, climate model temperature data for the UK will then be used to understand the future changes and their likely impact.

Type of project Literature review and computer-based simulation of power plant

Necessary background for the project:
Engineering graduate, or physicist with a good background in thermodynamics

Additional skills and expertise required for the project:
An interest in thermodynamics, and confident use of modelling software and common programming tools, such as Matlab

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Project P039 (Co-supervised with Gareth Harrison)

Title: The effect of combined renewable energy platforms on electricity networks

Short Description:
A previous MEng student carried out a project analysing some aspects of co-located wind and wave generation platforms, and included a small study using PowerWorld to assess the impact of a hypothetical wind-wave farm on the distribution network. This project aims to take this previous work as a starting point and carry out a more detailed investigation, using high resolution resource data with the PSSE software. There may also be interesting effects to investigate on a macro scale, with a suggestion that a mixture of wind and wave power rather than a single technology would be more reliable at times of peak consumer demand. This would benefit the electricity networks in terms of reduced requirement for standby generation and/or complex management strategies, and could increase the capacity credit allocated to combined generators.

Necessary background for the project: Electrical engineering first degree

Additional skills and expertise required for the project: Previous experience with PSSE would be desirable.

Supervisor Name: Robin Wallace

Project P040

Title: Network Integration of the 2020 Target Marine Energy Generating Capacity
Short Description: The UK has set ambitious targets to install 1600 MW of wave and tidal energy generation in the waters off the northern tip of Scotland. The distribution and transmission network in this area was designed and installed to supply the local demand before this expectation arose. This project will model the northern Scottish network and explore the network impact and possible mitigation measures of several development scenarios.
Type of project: Computer simulation and analytical study.
Necessary background for the project: Engineering or physical sciences degree
Additional skills and expertise required for the project: PowerWorld and Matlab.

Project P041

Title: Electrical Balancing of Renewable Energy Production
Short Description: Significant penetration of wind, wave and tidal energy if a future electricity mix will define a need for short, medium and long term production balancing with demand. This traditionally comes from kinetic energy exchange with the inertia of conventional rotating plant. Increasing the volume of energy storage or management associated with meeting the 2020 targets for renewable generation may involve regenerative braking, electric vehicle charging, demand response, and gravity based systems. This project will explore the role for these and other means of storing and recovering energy into the network.
Type of project: Computer simulation and analytical study project.
Necessary background for the project: Engineering or physical sciences degree
Additional skills and expertise required for the project: Matlab and Excel.

Project P042
Title: Wind to wire model of a wind-turbine generator
Short Description:
This project will develop a wind-to-wire model of a 500 kW wind turbine connected to a weak rural electricity network. It will create representative time series of wind velocities and local demand for electricity and the aerodynamic to mechanical and then mechanical to electrical energy conversion. It will implement an equivalent circuit of an induction motor, transformer and overhead line to perform power flow and network voltage analysis to determine the network impact or benefit of the presence of the wind generator. It will include an energy yield analysis and economic appraisal.
Type of project: Computer simulation and analytical study.
Necessary background for the project: Engineering or physical sciences degree
Additional skills and expertise required for the project: Matlab and Excel

Project P043

Title: Hydraulic-mechanical modelling of Pressure and Speed Rise in a Small Hydro Scheme
Short Description: On loss of electrical load, following generator field failure or network disconnection, the shaft speed of a hydro-generator will begin to accelerate towards overspeed. Water flow must be diverted (in impulse turbines) or reduced (in reaction turbines) quickly to reduce or avoid speed rise. Rapid flow reduction (even through valve closure) results in pressure rise in the water penstock supply pipe that can be destructive. This project will model the dynamic flow and speed phenomena to explore the inter-related effects of closure time, pipe length, pressure rise and shaft inertia in a small hydro generating scheme.
Type of project: Computer simulation and analytical study.
Necessary background for the project: Engineering or physical sciences degree
Additional skills and expertise required for the project: Matlab

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Project P044

Title: Network Impact of Variable Speed Drives in the FloWave TT Facility
Short Description: The FloWave (Test Tank) TT Facility currently being constructed at King's Buildings has 28 - 45 kW variable speed impellers that include power electronic supply and permanent magnet motors. Flow can be directed in any, and/or complex direction in the round tank by variation of the speed of the flow-drives to a pattern. Some will be heavily loaded, others more lightly. This project will model the electrical load of the tank and its harmonic content and potential distortion to the supplies in the building.
Type of project: Computer simulation and analytical study.
Necessary background for the project: Engineering or physical sciences degree
Additional skills and expertise required for the project: Matlab

Supervisor Name: Sasa Djokic

Project P045

Title: Impact of Meteorological, Socio-behavioural and Economic Factors on Load Profiling and Demand-side Management

Short Description: The main aim of this MSc project is to develop a general methodology for assessing variations in demand (structure and composition of system loads) due to changes in meteorological, socio-behavioural and economic factors. The project will combine probabilistic, statistical and measurement-based approaches to identify actual or estimated demand profiles at different time scales (hourly to yearly) and at different network buses, where load profile at a particular bus will be disaggregated to a probable composition of individual load categories and load sectors (e.g. residential, commercial, industrial, etc.). Stochastic variations in type, composition and amount of load connected at the bulk supply points will be analysed and quantified with respect to the changes in meteorological conditions (temperature, wind speed, solar irradiance, precipitation, etc), socio-behavioural and economic factors (demand variations between weekdays, weekends, holidays and important social events, as well as the demand responses to the electricity price or tariff signals). Different correlation, regression and clustering techniques will be used to identify the effects of the changes of the considered parameters and factors on the corresponding variations of the total/aggregate demands and contributions of the main load categories to this aggregate demand (annual/seasonal, weekly, daily/diurnal, hourly and sub-hourly variations). Special attention will be paid to the confident identification of the loads that could be target of demand-side management schemes and actions. This project will interact and possibly collaborate with two other projects related to modelling of residential and commercial loads and demands (see two projects below).

Type of project: Modelling, analytical representation and correlation of demands with meteorological, socio-behavioural and economic factors.

Necessary background for the project: Mathematical or general engineering preferred, but other degrees are also applicable.

Additional skills and expertise required for the project: Intermediate/Advanced knowledge in manipulating and processing large data sets.

Project P046

Title: Demand Aggregation and Management in Residential Load Sector

Short Description: Aggregate system loads are generally divided into three main load sectors: residential (or domestic), commercial (or general service) and industrial. Residential load sector is generally defined as houses or buildings for dwellings, whose sole purpose is to provide permanent residency to the occupants. Inherent similarities in characteristics and patterns of active and reactive power demands of end-users from the same load sector, allow to use the same or similar aggregate load models for the representation of their aggregate demands.

In order to provide more accurate load models, one load sector may be further divided into several sub-sectors. The proposed MSc project will use available data and statistics on energy demands and consumptions in the UK to identify typical structure and composition of loads found in different residential load sub-sectors: highly urban, urban, suburban and rural. This work will build on the previous research on load modeling at the Institute for Energy Systems (IES), and the analysis will include current and anticipated changes in technology, as well as the relevant regulative and legislative aspects (e.g. ban of incandescent lamps, introduction of "smart meters", connection of electric vehicle plug-in chargers, etc.), in order to estimate and compare short-term (2015-2020) and medium to long-term (2030-2050) changes with the existing load mixes. As in the previous project, special attention will be paid to the identification of the residential loads that could be target of demand-side management schemes and actions. This project will interact and possibly collaborate with two other projects related to modelling of loads and demands (see previous and next project).

Type of project: Modelling, simulation and analysis of loads and power supply systems.
Necessary background for the project: Electrical and/or Electronics preferred, but other degrees (e.g. Mechanical) are also applicable.
Additional skills and expertise required for the project: Basic/Intermediate knowledge of electrical power engineering and computer simulation/modelling.

Project P047

Title: Demand Aggregation and Management in Commercial Load Sector

Short Description: As mentioned for the previous project, aggregate system loads are generally divided into three main load sectors: residential (or domestic), commercial (or general service) and industrial. Commercial load sector consists of public, private and voluntary establishments and businesses, which are generally aimed at providing specific services to the public. The commercial load sector does not involve general product manufacturing and material processing activities, which are classed as industrial sector. Accordingly, industrial sector loads are defined as electrical equipment and devices employed in any business that performs raw or any other level of material processing, fabrication or manufacturing, or similar activities. Inherent similarities in characteristics and patterns of active and reactive power demands of end-users from the same load sector, allow to use the same or similar aggregate load models for the representation of their aggregate demands.
As in the previous project, the proposed work will use available data and statistics on energy demands and consumptions in the UK to identify typical structure and composition of loads found in different commercial load sub-sectors (commercial load sector is also divided into several sub-sectors in order to provide more accurate load models): offices, education, health, hotel & catering, communication & transport, retail and sport & leisure. Again, this work will build on the previous research on load modeling at the Institute for Energy Systems (IES), and the analysis will include current and anticipated changes in technology, as well as the relevant regulative and legislative aspects (e.g. electrification of transport, use of high-efficiency HID light sources, drive-controlled motors, etc.), in order to estimate and compare short-term (2015-2020) and medium to long-term (2030-2050) changes with the existing load mixes. Similarly to the previous two projects, special attention will be paid to the

confident identification of the commercial loads that could be target of demand-side management schemes and actions. This project will interact and possibly collaborate with two other projects related to modelling of loads and demands (see two previous projects).

Type of project: Modelling, simulation and analysis of loads and power supply systems.
Necessary background for the project: Electrical and/or Electronics preferred, but other degrees (e.g. Mechanical) are also applicable.
Additional skills and expertise required for the project: Basic/Intermediate knowledge of electrical power engineering and computer simulation/modelling.

Project P048

Title: Power Quality Aspects of Operation of Urban PV and Wind Micro-generation Systems

Short Description: The proposed MSc project will continue previous research on modelling of loads and distributed generation technologies at the Institute for Energy Systems (IES), in which steady state models are developed and used in load flow, voltage profile and other similar studies of power supply systems. These models will be modified and/or improved to allow for the correct assessment of system power quality performance and particularly modelling of harmonic interactions. The work will also include ongoing and anticipated changes in technologies introduced by so called "smart grids" (e.g. HVDC, FACTS and inverter-interfaced DG on supply side, as well as EV chargers, CFLs, ASDs, SMPS' and "smart meters" on demand side). The developed models will be validated using the available field and measurement data and then aggregated, in order to correctly represent large number of PV/Wind micro-generators (hundreds and thousands) connected to the grid in a large urban area. This project will concentrate on the assessment of PV/Wind micro-generation impact on power quality system performance, but it will be coordinated with another MSc projects related to the assessment of reliability performance (see next project).

Type of project: Analysis and simulation (in MatLab) of small-scale PV/Wind distributed generation connected to the low-voltage distribution systems.
Necessary background for the project: Electrical and/or Electronics degree are required.
Additional skills and expertise required for the project: Intermediate/Advanced knowledge of power system operation and modelling.

Project P049

Title: Reliability Aspects of Operation of Urban PV and Wind Micro-generation Systems

Short Description: As in the previous project, this work will continue previous research on modelling of loads and distributed generation technologies at the Institute for Energy Systems (IES), in which steady state models are developed and used in load flow, voltage profile and other similar studies of power supply systems. These

models will be modified and/or improved to allow for the correct assessment of system reliability performance and particularly ability of PV/Wind micro-generators to provide system support and ancillary service (frequency and voltage support, as well as the provision of an alternative supply). The work will also include concept of a "virtual power plant" (VPP), which allows for a coordinated control and operation of a number of distributed generation/storage resources within the same LV/MV network. Similarly to the previous project, the developed models will be validated using the available field and measurement data and then aggregated, in order to correctly represent large number of PV/Wind micro-generators (hundreds and thousands) connected to the grid in a large urban area. This project will concentrate on the assessment of PV/Wind micro-generation impact on system reliability performance, but it will be coordinated with another MSc projects related to the assessment of power quality performance (see previous project).

Type of project: Analysis and simulation (in MatLab) of small-scale PV/Wind distributed generation connected to the low-voltage distribution systems.

Necessary background for the project: Electrical and/or Electronics degree are required.

Additional skills and expertise required for the project: Intermediate/Advanced knowledge of power system operation and modelling.

Project P050

Title: "**Smart Grid" Charging of Electric Vehicle Batteries**

Short Description: Correct models of electric vehicle (EV) batteries, chargers and control circuits are necessary to fully understand impact of increased penetration of EVs on electrical network (during the charging of EV batteries) and their carbon saving effects in the transportation sector (when EV batteries are discharged). Previous work at the Institute for Energy Systems developed basic models of EV chargers, lithium-ion batteries and control circuits for their normal and fast charging conditions. This project will build on that work (and also interact with other similar MSc projects, particularly one related to electro-chemical modelling of EV batteries and another one related to the modelling of EV chargers), in order to develop improved and more accurate models for analysing aggregate impact of large EV penetration on: modification of load profiles and demands, improvement/deterioration of network performance, carbon saving/offsetting potential and use of EV batteries and two-way chargers as distributed energy storage systems. This work will help to put anticipated electrification of transport and large deployment of EVs in the context of the future "Smart Grids".

Type of project: Analysis and modelling of EVs.

Necessary background for the project: Electrical and/or Electronics preferred; other degrees may be applicable, but please consult and check before selecting.

Additional skills and expertise required for the project: Basic/Intermediate/Advanced knowledge of power electronics and computer simulation/modelling.

Supervisor Name: Adam Collin

Project P051

Title: Modelling of LED light sources for power system studies

Short Description: The recent phase-out of general incandescent lamps (GILs) will help to encourage their replacement with energy efficient alternatives, e.g. compact fluorescent lamps (CFLs) and light-emitting diode (LED) light sources. These energy efficient light sources contain power electronic control circuits which help to improve their performance, but which may have adverse effects on the wider power system.

This project is part on an ongoing effort within the Institute for Energy Systems (IES) to build an extensive 'load model library' for power system studies. This work will use an existing load development methodology to combine laboratory measurements and simulation work to produce simple representations of LED light sources. The developed LED model will then be used to quantify the effects of LED light sources on the operation and performance of typical UK networks.

Type of project: electrical modelling, laboratory measurements, power system analysis, simulation.
Necessary background for the project: electrical/electronic engineering or similar background.
Additional skills and expertise required for the project: understanding of power electronics.

Project P052

Title: Multi-scale analysis of electrical power systems: filling in the gaps

Short description: In recent years there has been growing interest in the operation and performance of low-voltage (LV) networks and the connected loads. This is a consequence of increasing support for 'smart grid' operations, of which many, e.g. demand-side management (DSM), will take place in the LV network. However, there is still a general lack of information and measurements of LV networks, which is essential for analysing the wider area impact of smart grid functionalities.

This project will attempt to consolidate LV network measurements currently available within the Institute for Energy Systems (IES), which range from individual devices to larger sections of the network, for the purposes of network analysis. The measured data will be analysed and used as input to improve and further develop existing multi-scale power systems simulation tools.

Type of project: data analysis, measurement analysis, power system analysis, simulation,

Necessary background for the project: electrical/electronic engineering or similar background.

Additional skills and expertise required for the project: none.

Project P053

Title: Modelling the seasonal variability in residential loads

Short description: Changes in the ambient conditions are known to have a significant impact on the way that people interact with their household loads. The most obvious example of this is the need for increased lighting demand during the dark winter months. These seasonal (i.e. temporal) variations in household energy demand have a strong influence on the operation of the electricity network and are required for accurate analysis of many 'smart grid' functionalities, e.g. electric vehicle (EV) charging or demand-side management (DSM)

This project will begin by investigating the impact of changes in ambient conditions on the energy consumption of the most common UK household loads. Simple power demand models will be developed which will be combined using a bottom-up modelling methodology to assess the influence of changes in external temperature and solar irradiance on the overall energy demand of typical UK households. A detailed case study on an area of interest to the student (e.g. EV charging, DSM, or use of heat pumps) will be used to put the results into context.

Type of project: general modelling

Necessary background for the project: basic electrical engineering or similar

Additional skills and expertise required for the project:

Supervisor Name: Mathew Topper

Project P054

Title: Reaching up to Policy

Short Description: The 2010 UKERC/ETI Marine Energy Technology Roadmap identified wave and tidal device modelling tools as a `Priority A' requirement for the industry. What was not clearly established was the scale of resources required to accomplish this ambiguous and ambitious goal in the given time frame of six years. These requirements are, at this stage, difficult to determine as the level of technical capability within the research community is not well understood. This is particularly true of software models, where often the research community works at the cutting edge of applied science and the applicability and level of testing of various approaches is currently unclear.

This project seeks to demonstrate a method with which the research community can "reach up" to policy makers and funding bodies in order to illuminate the most critical technical needs of the research community (rather than the needs of industry, for example). By utilising high level Verification and Validation (V&V) techniques, the current technical capabilities of the research community can be documented and the research of greatest value identified. The project will attempt to lay out a formal description of this process for the marine renewable energy industry, and practically demonstrate the value of such techniques using projects such the SuperGen Marine Energy Research Consortium as a case study.

Type of project: This project is mainly literature based. It will establish a methodology for identifying the current state of research for a particular technology (such as tidal turbines) through existing published material, interviews and questionnaires as necessary. The methodology will then be applied to a completed research project to provide evidence of its effectiveness.

Necessary background for the project: Competent writing and verbal skills are required for this project. Additionally, an interest in research and renewable energy policy is desirable. Understanding of interview techniques and questionnaires will also add value.

Additional skills and expertise required for the project: Some interest in modelling would be desirable, but not essential.

Project P055 (in collaboration with Jean-Baptiste Richon)

Title: Wave Generators and Vortex Formation

Short Description: John Scott Russell discovered the solitary wave while experimenting with canal boats on the Union Canal at Hermiston, Edinburgh. He was astonished by the properties of this wave, remaining virtually unchanging in speed and shape as it travelled along the canal. Russell named these waves "waves of translation", but they are now more commonly known as solitary waves. These waves are extremely useful for numerical modellers of water waves as their properties can be used to easily determine whether a model is working or not. The problem lies in creating these waves, either in the numerical or physical form. John Scott Russell designed a wave generator which uses heavy box plunging into a long, narrow flume of water. After recreating a similar generator, it was found that the quality of these waves are reduced by parasitic vortices created by the generator. This project will research the impacts of these vortices on the creation of solitary waves by using laser particle image velocimetry in the University of Edinburgh wave flume and validating with numerical models (such as Starccm+). The ultimate aim of the project is to understand the exact flow field about the wave generator and then design and test improvements to the generator as a result.

Type of project: The main work of this project will be the experimental measurement of water motion using particle image velocimetry. There is also the opportunity to design improvements to the existing wave generator in light of the results acquired. Numerical models, such as Starccm+, will be used to support the results of the physical experiments. In addition, the results can be compared to an in-house research code that is already capable of modelling solitary waves. Nonetheless, effort will be mostly placed into experimental measurement of the flow about the wave generator and improvements to the design of the generator.

Necessary background for the project: Experience of undertaking experiments is essential. Additionally, candidates with design and fabrication skills are ideally suited to this project.

Additional skills and expertise required for the project: Experience of using numerical models, such as CFD, would be advantageous but not the primary focus of the project.

Supervisor Name: Mark Winskel

Project P056

Title: UK energy-electricity futures and the contested role of gas

Short Description: UK energy policy has become politically contested in recent months. One of the central controversies has been diverging views about the compatibility of gas-based electricity generation with the UK's broader climate and energy policy ambitions. The aim of this study is to conduct an evidence-based review of this issue, in terms of the robustness of different scenarios of UK energy futures. Key issues to be included here will be price and cost assumptions for fuel and technology, asset utilisation and lifetime, and the treatment of uncertainty in scenarios. The study will be carried out in the context of key policy developments such as the UK Governments Electricity Market Reform and Gas Strategy.

Type of project Policy evaluation, including assessment of scenario assumptions and methods.
Necessary background for the project No specific degree requirement.
Additional skills and expertise required for the project: Good qualitative and quantitative research skills. Keen interest in reading and analysing policy documents. Excellent written English.

Project P057

Title: An assessment of the German *Energiewende* (energy transformation).

Short Description: In the wake of the Fukushima crisis, the German government has set a highly ambitious plan for the radical transformation of its energy system, with the abandonment of nuclear power and phasing out of fossil fuels. The *Energiewende* includes challenging short, medium and long term targets, and in reaching these, German policymakers are seeking to harness a combination of top-down and bottom-up measures. The credibility of the plan is already being contested – some refer to it as 'Germany's gamble'. The aim of this research is to conduct a technical, economic and political assessment of the feasibility of the Energiewende, and consider the extent to which it represents a uniquely German approach, or whether it might be translated to different European states, such as the UK.

Type of project Policy evaluation, including assessment of scenario assumptions and methods.
Necessary background for the project No specific degree requirement.
Additional skills and expertise required for the project: Good qualitative and quantitative research skills. Keen interest in reading and analysing policy documents. Excellent written English.

Supervisor Name: Tom Bruce

Project P058

Impact loads in floating body collision with wave and tidal energy converters [1]

Tidal and wave energy converters may experience large loads due to collision with a floating body. This could be flotsam (eg a shipping container), or a marine animal (eg a seal). Very little is known about the probability of such events, or the maximum (design) loads that should be associated with an event. A recently-funded, collaborative EPSRC project will see experiments carried out at Edinburgh in 2013.

This project will assist in preparation for these experiments by designing, developing and testing an instrumented floating body (or bodies), incorporating the latest, six-degrees-of-freedom solid-state accelerometers. Once commissioned, some exploratory measurements will also be made.

Type of project: mechanical / instrumentation design and laboratory testing

Necessary background for the project: -

Additional skills and expertise required for the project:

MATLAB or similar, for handling of large data sets.

Project P059

Impact loads in floating body collision with wave and tidal energy converters [2]

Tidal and wave energy converters may experience large loads due to collision with a floating body. This could be flotsam (eg a shipping container), or a marine animal (eg a seal). Very little is known about the probability of such events, or the maximum (design) loads that should be associated with an event. A recently-funded, collaborative EPSRC project will see experiments carried out at Edinburgh in 2013.

This project will extend the scope of the project by exploring whether pressure sensitive film could be deployed on a model turbine rotor to measure the location and spatial extent of impacts. Once set up and calibrated, some exploratory measurements will be made with a fixed blade. (This project sees a collaboration with University of Southampton).

Type of project: mechanical / instrumentation design and laboratory testing

Necessary background for the project: -

Additional skills and expertise required for the project:

MATLAB or similar, for handling of large data sets.

Project P060

Wave loading at breakwater-integrated OWCs – physical model study

The idea of integrating wave energy converters (WECs) into breakwaters has been around for a long time – the need for a breakwater suggests an energetic wave climate. The scheme at Mutriku, in the Basque region of Spain, has recently begun generation, but was significantly delayed by serious storm damage during construction. Uncertainties in design for wave loading, machine performance and constructability remain crucial in economic assessment of this type of scheme, and will dictate whether this type of WEC has a future.

This project will examine these uncertainties, and proceed to explore issues surrounding uncertainties on wave loading and structural response. The main platform for testing is anticipated to be small-scale modelling in the Institute's 20m flume. Large-scale equivalent tests are scheduled to take place in the very large wave channel, "GWK", in Hannover, Germany, in November/December 2013. While the project does not require data from these tests, it may be that it aligns well if the large-scale tests proceed as planned, with the opportunity for direct scale-effects comparisons.

Specific area covered: Marine, Fluid mechanics

Type of project: physical modelling; data handling and critical appraisal

Necessary first degree for the project: Mechanical / Civil Engineering

Necessary skills and expertise for the project: experience in instrumentation calibration, deployment; data acquisition; ability to process very large amounts of data (beyond what can be done in Excel => MatLab skills essential).

Desired skills and expertise for the project:

Project P061

Edinburgh schools: energy use and planning

The Carbon Trust has recently published guidance in energy use and approaches to its reduction in schools. A previous MSc study (and follow-up MEng project) have devised a detailed energy model of Craiglockhart Primary School – a 107 year-old sandstone building (where the supervisor's daughters go to school!).

Interest has been sparked at a number of other primary schools in the city – principally others housed in similar, attractive Edwardian sandstone buildings, with little of no energy management strategies or tool. This project will start by critical appraisal of work to date, followed up by exploration, with other schools, and with the City of Edinburgh Council, how the work can be taken forward to practical implementation. As part of this, approaches will need to be considered on the basis of cost, and also on carbon savings over a design period.

Type of project: Paper-based; site visits; linked to energy costing / green incentive policies; requiring significant external communications.

Necessary first degree for the project any possible

Necessary skills and expertise for the project: Information-mining; inter-personal skills / communication skills; spread-sheeting

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Project P062

School of Engineering energy audit

Short Description:
The School's estate comprises a huge variety of buildings, both in terms of their basic structure and their usage. While the fact that KB site boasts a 2.7MWe combined heat and power (CHP) plant gives some sense of "clean" energy usage, there exists no detailed model of the School's overall energy use and its building losses. This project will build on a successful start (a study of the Faraday Building) and widen modelling to more (ideally, all) the School's buildings in terms of their energy budgets. It will then proceed to use these models to analyse a variety of strategies to reduce demand and waste.

Type of project: Paper-based; site visits; linked to energy costing / green incentive policies; requiring significant external communications.

Necessary first degree for the project any possible

Necessary skills and expertise for the project: Information-mining; inter-personal skills / communication skills; spread-sheeting

Supervisor Name: Venki Venugopal

Project P063

Wave/current kinematics measurements using a Perforated ball velocity meter

Short Description: This project involves testing a Perforated ball Velocity Meter (PVM), which is essentially a drag device, in which a perforated hollow ball is mounted on a strain-gauged cantilever. Among velocity measuring instruments, the Perforated ball Velocity Meter (PVM) has certain advantages over others when used in large hydrodynamic test facilities. It can measure all the three components of wave particle velocities and the measurements can be made at different water depths. The PVM measurements will also be used to understand the turbulence behaviour in a tidal flow.

Type of project Experimental
Necessary background for the project: Any
Additional skills and expertise required for the project: Matlab

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Project P064

Studies on oscillating water column type wave energy device – Flowpot

This project involves developing an oscillating water column type wave energy device. The device has already been built; however, it needs some new design of electrical components and few other modifications. The project concentrates on the testing of a scale model of the proposed wave power device (Flowpot – **FLO**AT ASSISTED **W**AVE **PO**WER **T**URBINE) in the wave flume, to measure its power production capability and assess its performance in different wave conditions.

Type of project Experimental

Necessary background for the project Any

Additional skills and expertise required for the project: Matlab/Excel

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Project P065
Motion response measurements of floating wind turbine

A spar type floating wind turbine's motion responses will be measured in this project. The spar has been already fabricated and tested. Further testing with moorings will be carried out in this project. This is an experimental work using curved wave basin. You will measure wave loads on the moorings and surge, heave & pitch motions of the spar in mulit-directional waves. Analysis will require Matlab.

Type of project Experimental
Necessary background for the project Any degree
Additional skills and expertise required for the project: Matlab/data analysis skills

Project P066

Wave run-up on offshore wind turbine

Short Description: Offshore structures are mainly consisting of circular members; for example, a jacket platform leg, a monopile of offshore wind turbine, semi-submersible columns etc. This project work involves CFD modelling of wave run-up on a circular cylindrical member. The results will be presented in the form of design formulae and compared with available experimental results.

Type of project CFD/Simulation

Necessary background for the project Mechanical

Additional skills and expertise required for the project: C++, Matlab

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Project P067

Shallow water wave and current induced forces on an offshore wind turbine monopole

Short Description: Wind turbines have progressively grown in size over the past 20 years. These large sized offshore turbines experience a multitude of loading including wave loads, sea currents and ice loading etc. Once these loads are calculated accurately, the monopile, foundation and other supporting members can be safely designed. This project will look into the numerical methods to calculate the combined nonlinear shallow water and current forces on the pile. Some structural design elements of the monopile will also be carried out. Matlab programming skill is necessary.

Type of project Analytical

Necessary background for the project Mathematics based

Additional skills and expertise required for the project: Matlab programming skills

Supervisor Name: Dimitri Mignard

Project P068

Title: **Storage of hydrogen energy using sponge metals**

Short Description: Hydrogen is the fuel that can be most readily generated from renewable power, but the compact, safe and energy-efficient storage of this gas is an issue. This issue is also encountered in refineries, where supplies of hydrogen can be tight and buffer storage in geological formations not always an option. A potentially advantageous scheme consists in reacting the hydrogen with iron oxides (reduction) to produce very porous iron metal. The hydrogen can then be regenerated by oxidising the iron with steam or hot water. In summary, $Fe_3O_4 + 4H_2 \leftrightarrow 3Fe + 4H_2O$. However, with iron the equilibrium concentration of hydrogen at 600^oC is rather high at 77 % mol, which implies that most of the hydrogen must be recycled back to the reactor. This is not desirable. Preliminary investigations are suggesting using instead of iron binary or ternary alloys that give mixed oxides. For example with spinels, $AB_2O_4 + 4H_2 \leftrightarrow AB_2 + 4H_2O$. Preliminary work has developed a model for the prediction of alloys and their oxides with favourable thermodynamic properties, and initial testing in the laboratory was encouraging.

Aims:

- Update the literature survey on the kinetics of the reaction
- Cycle particles in the laboratory
- Check the equilibrium concentrations of hydrogen in the laboratory
- Perform a kinetic study in the laboratory
- If time allows, prepare more particles for testing

Type of project: thermodynamics and materials sciences, chemistry and chemical engineering. Modelling and experimental.
Necessary background for the project: Chemical Engineering, Materials Sciences, Chemistry, Chemical Thermodynamics
Additional skills and expertise required for the project: Attendance of a (free) Radiation Safety course would be a boon for performing X-ray diffraction analysis on prepared samples. Please note, maintaining a tidy workspace in the lab, labelling all containers and keeping an accurate lab book are essential but not sufficient requirements.

Project P069

Title: **Modelling of low-impedance $LiFePO_4$ batteries for electric vehicles**

Short Description: As the outlook for Electric Vehicles (EVs) is looking increasingly favourable, e.g. due to recent advances in compact, high power and high energy density batteries, as well as helpful government policies (e.g. substantial subsidies in the UK), the question arises as to whether the generation and distribution network can handle the large additional demand for power that would necessarily accrue from widespread use of EVs.

- Tackling this question would require an adequate simulation model describing the charge and discharge of an EV battery pack as a first step ***– this being the main aim of this project***.

- To assist with this task, you will generate experimental data from $LiFePO_4$ batteries for EV using a technique known as Electrochemical Impedance Spectrometry (EIS). From the data you will infer an Equivalent Circuit Model (ECM) for the batteries, as well as I-V curves for charge and discharge.

- Prior to this however, you will need to address issues regarding the noise to signal ratio of the measurement. To this end, you will explore the use of filters and amplifiers, and specifying or even designing and building one if appropriate.

Type of project: Modelling and experimental.

Necessary background for the project: An Electronics background would be helpful. More generally, the project will only suit a *very good* student in Engineering, Material Sciences, Chemistry or Physics too – a scientist or engineer worthy of this name will pick up what they need from disciplines that they are less knowledgeable about.

Additional skills and expertise required for the project:
Experience of programming with Matlab or C or similar language.

Project P070

Title: Predictive model for the properties and structure of char as a function of composition and structure of biomass feedstock

Short Description:

Pyrolysis of biomass for the production of char could be an enabling technology for a number of bioenergy-related processes, which at a stroke would solve the problems of seasonal availability and mixed sources. Storing the biomass in the form of char avoids degradation of the biomass during storage. A char feedstock from mixed biomass sources could also have properties that are more homogeneous than the original feedstocks were, helping to bring costs down for bioenergy technologies. This is particularly relevant to biomass gasifiers for the production of power and second generation biofuels: Any one design is usually not very versatile with respect to feedstock. Typically, higher yields of char are obtained from so-called 'slow pyrolysis' and hence it is this process that should be the focus of this project.

The project aims at producing a parametric kinetic model for the yield of char and the development of char properties as a function of feedstock composition (cellulose, hemicellulose, lignin. ashes) and structure (Composition and shape of cell walls?), and pyrolysis conditions. A preliminary task in the initial survey will identify and describe the properties of the biomass and of the chars that are relevant (likely to include composition, density, pore size, ash content and its melting point, but also yield of char during the pyrolysis, moisture content and calorific values).

Type of project: Theoretical and modelling. If time and circumstances allow, there may be a possibility to assist with experimental data collection.

Necessary background for the project: Chemical Engineering or Chemistry or even Biology (requires knowing the basics of chemical kinetics), although any self-respecting good engineer or scientist will be able to pick up what they need from disciplines that they are less knowledgeable about.

Additional skills and expertise required for the project: Basic chemistry and kinetics theory is essential.

Project P071

Title: Practicalities of using disused gas reservoirs for geological storage of renewable hydrogen

Short Description:

Hydrogen can be generated from renewable power sources by a process known as electrolysis, and also from a number of biofuels or fossil fuels. Provided that the storage capacity exists for it, it has the potential of providing seasonal storage of energy to buffer the wide year-on-year variability of the capacity factor of renewable power sources like wind or marine energy.

The process is in fact already current practice with natural gas. The depleted Rough reservoir, which is located offshore in North East England, is used as buffer storage and can meet the UK current demand for natural gas for several weeks, hence the potential of this method as a possible short-term back up for renewable generation, as well as longer term for seasonal storage.

However, we anticipate the following type of issues: Pressure losses might be significant; the hydrogen would get contaminated by residual gas (present as residual pressure in the reservoir), potentially requiring extensive purification for meeting standards required by the end-user unless injection back into gas pipelines was used (itself currently a moot point in the UK); and the geographical proximity of the reservoirs and sources of renewable powers would need to be looked at (pipelines and electric cables do not come cheap!). The aim of this project is to look at these issues, develop a suitable model to appraise the economics of this type of project, and attempt a case study.

Type of project: Techno-economic evaluation of production methods.

Necessary background for the project: degree in engineering, or physical or biological science.

Additional skills and expertise required for the project: Depending on the students' background, must be able to assimilate and apply basic knowledge form other disciplines, e.g. process engineering and geology.

Project P072

Title: Modelling of a CO_2 – to methanol plant at variable feed flow rate for the conversion of wind, marine or solar power to fuel.

Short Description:

Typically, processes that seek to convert CO_2 and renewable energies to fuels using commercially available technology are of the following type:

Step 1, Electrolysis: Water → Hydrogen + Oxygen
Step 2, Synthesis: CO_2 + Hydrogen → Carbon-based fuel (+ water by-product)

Step 1, which is powered by the renewable energy source, can easily be operated at the variable rate that is imposed by that source, with a turndown ratio of 6:1.

However, this is not necessarily so with Step 2 which, if not operable at variable flow rates, will require the use of bulk hydrogen storage to cover periods of low production that can range from hours to weeks. However, in the absence of nearby geological storage such as salt caverns, depleted oil reservoirs, etc., the limitations of compressed H_2 storage on the required scale are prohibitive.

The alternative is excessively frequent shutdown and start-up of the synthesis plant, which is time consuming and inefficient given the process requirements (e.g. heating up of large structures to operating temperatures and build-up of inventories and recycle streams) as well as safety aspects (purging with nitrogen, etc).

Fortunately, some processes, such as methanol synthesis, are in principle operable with turn-down ratios of 6:1 provided that the reactor has been carefully designed, and this should reduce the required scale of buffer hydrogen storage. Methanol is a liquid that can then be stored, and ether used directly as fuel or processed further to make synthetic petrol, diesel, etc. The question is then, how does one run this process so that the changes in flow rates can be smoothly accommodated without any upset? The project will simulate a simple process flowsheet for the synthesis of methanol from CO_2 at variable flow rate including hydrogen buffer storage, with the help of the Unisim® simulation software.

Type of project: Process modelling

Necessary background for the project: Chemical Engineering, but any self-respecting good engineer or scientist will be able to pick up what they need from disciplines that they are less knowledgeable about.

Additional skills and expertise required for the project:
Prior experience with Chemical Process modelling will help, but not absolutely necessary for a very good student.

Project P073

Title: Economic evaluation of renewable energy projects using macroeconomic parameters

Short Description:

The financing of renewable energy is often the stumbling block to larger deployment of these technologies. Not only the upfront capital costs are typically high, investors will also demand higher rates of financial returns if the perceived risks are high due to uncertainty on government policies for support and subsidies of these technologies, or the lack of technological maturity of some of these technologies.

Capital costs are themselves dependent on factors such as: the balance of supply and demand, and the number of players in the field; productivity and labour costs; raw materials and energy costs; and financing costs for players along the production chain.

Previous work for the capital cost of erected plants has led to a model that could predict capital costs escalation (inflation) as a function of only two macro-economic parameters, namely interest rates for business and oil prices. You will seek to extent a similar approach to the cost of renewable energy projects, distinguishing between different types of projects from the point of view of commercial and technological maturity.

Type of project: Techno-economic modelling

Necessary background for the project: preferably Engineering, in any case with a good grasp of economic and policy issues.

Supervisor Name: Hannah Chalmers

Project P074

Title: Flexible CO2 compression for CCS power plants

Short Description: Carbon capture and storage (CCS) technologies could be used to significantly reduce carbon dioxide (CO2) emissions at power plants burning fuels that contain carbon, e.g. coal, natural gas and biomass. An important part of many CCS projects is compression of CO2 that has been captured from a power plant before it is transported for safe storage. This project will consist of a systematic desk-based study to identify key variables that could affect the electricity required for CO2 compression at power plants operating within CCS schemes throughout their operating lives. These could include meeting requirements related to integrating different components of CCS systems and also potential technology changes during the project operating life – which will typically be at least 20-30 years. The modelling will initially focus on understanding the thermodynamic requirements and implications of different design choices, but may be expanded to include other considerations as the work develops.

Type of project: Computer simulation, analytical study
Necessary background for the project: Knowledge and understanding of thermodynamics (to the level of a typical mechanical engineering first degree graduate as a minimum).
Additional skills and expertise required for the project: Reasonable ability in a relevant software package (e.g. Mathcad, Matlab…) would be beneficial

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Project P075

Title: Opportunities and challenges for biomass-enhanced carbon capture and storage (BECCS)

Short Description: Carbon capture and storage (CCS) technologies are being developed to significantly reduce carbon dioxide (CO_2) emissions from large point sources of these emissions, such as power generation and cement manufacture. Most attention has so far been devoted to CCS applied to fossil fuels such as coal and gas. There has, however, been increasing interest in the potential for CCS to combined with biomass combustion to create the potential for 'negative emissions' since CO_2 removed from the atmosphere by biomass as it grows. This project will undertake a critical review on opportunities and challenges for combining biomass use with CCS, considering both technical and non-technical issues. Additionally, quantitative modelling to explore different factors that might affect how biomass is used (e.g. in relatively large power stations or more locally) will be undertaken.

Type of project: techno-economic evaluation, computer simulation, analytical study
Necessary background for the project: This project is likely to require detailed review of a significant amount of literature, so excellent understanding of written English is essential. Also, must have a numerate degree and previous experience in mechanical engineering is likely to help significantly
Additional skills and expertise required for the project: Reasonable ability in a relevant software package (e.g. Mathcad, Matlab…) would be beneficial

Project P076

Title: Potential for reuse of existing infrastructure for CCS applications in the UK

Short Description: Carbon capture and storage (CCS) technologies are being developed to significantly reduce carbon dioxide (CO_2) emissions from large point sources of these emissions, such as power generation and cement manufacture. In some countries, including the UK, commercial-scale demonstration projects are under development and some organisations are beginning to plan for potentially more widespread roll-out of these technologies. This project will identify and analyse key factors that could influence if and how existing infrastructure will be used for CCS projects in the UK. Technical and non-technical issues will be considered.

Type of project: techno-economic evaluation, computer simulation, analytical study

Necessary background for the project: This project is likely to require detailed review of a significant amount of literature, so excellent understanding of written English is essential. Knowledge and understanding of thermodynamics (to the level of a typical mechanical engineering first degree graduate as a minimum) is also required.

Additional skills and expertise required for the project: Reasonable ability in a relevant software package (e.g. Mathcad, Matlab…) would be beneficial

Supervisor Name: Ondrej Masek (Please note: if you'd like to select one or more of Ondrej's projects, you should first discuss them with him.)

Project P077

Title: Effects of biomass pre-treatment on biochar yield and properties

Short Description:

Biomass and organic materials are a promising material for renewable power generation as well as for climate change mitigation in form of biochar. By modifying the properties of different biomass feedstock it is possible to significantly affect the way in which these materials perform during thermochemical conversion. This has impact in many different areas from combustion to pyrolysis and gasification. This project will investigate the effects that physical, chemical and thermal treatment of biomass feedstock has on their torrefaction/ pyrolysis and on properties of the resulting solid products. The proposed project will be a combination of desk-based study and experimental work in laboratory.
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P078

Title: Modification of biochar properties by oxidative and thermal treatment

Short Description:

Biochar, the product of biomass pyrolysis is a promising technology for climate change mitigation by removing and stabilising atmospheric CO2 while also improving agricultural productivity. By modifying the production conditions during or post pyrolysis it is possible to considerably affect the properties of the resulting product in ways that are beneficial for its application, such as higher stability, improved physical/ chemical properties etc.

The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project: degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P079

Title: Biochar forensics/ quality assurance

Short Description:
Biochar, the product of biomass pyrolysis is a promising technology for climate change mitigation by removing and stabilising atmospheric CO2 while also improving agricultural productivity. Depending on the feedstock and production process used, it is possible to produce a wide range of biochar products, some of which are more suitable for certain applications than others. As the development and deployment of biochar progresses, it will become more and more important to be able to test and verify quality of the different products by methods that are relatively straightforward and effective. Therefore, this project will work on development of methods for characterisation of biochar that are able to distinguish among many different types of char and verify that these have been produced to certain standard or according to prescribed methodology. As a result, the outcomes of the project will have considerable practical implications.
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.
Type of project dissertation
Necessary background for the project: degree in engineering or sciences

Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P080

Title: Secondary char formation and its impact on biochar properties

Short Description:
During pyrolysis of biomass, char (primary char) is formed from the original material by thermal decomposition and reorganisation of the main building blocks of biomass (lignin, cellulose and hemicellulose), releasing gaseous and liquid (vapour) co-products. In certain cases, it is possible to encourage formation of additional char, so called "secondary char" by allowing the primary char to react with pyrolysis vapours. In this way it is possible to not only increase the yield of char, where that is desirable, but also to modify its properties. This project will investigate the potential of secondary char to improve stability of biochar (relevant to its carbon sequestration potential) and its properties (relevant to improving agricultural performance).
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project : degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P081

Title: Interaction of biochar with mineral matter for improved stability and functionality

Short Description:
Biochar, is the product of biomass pyrolysis and it is a promising technology for climate change mitigation by removing and stabilising atmospheric CO2 while also improving agricultural productivity. Typically, biochar is produced from woody biomass or agricultural residues on their own. However, there is some evidence

suggesting that beneficial interaction of biochar with mineral matter may be a feasible way to boost biochar's performance in climate change mitigation by improving its yield and properties.
Therefore, this project will focus on the interaction of biomass with mineral matter in different form and on the properties of the resulting biochar. This will involve production of biochar in laboratory units as well as its characterisation.
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project: degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P082

Title: Hydrophobicity of thermally processed biomass

Short Description:

Thermal processing of biomass, i.e. torrefaction/ pyrolysis, can yield solid materials with considerably altered properties compared to the starting feedstock. This can be beneficial for use of these materials in either power generation (combustion/ gasification) or for climate change mitigation in case of biochar (stabilised carbon). One of the important parameters for both applications is the hydrophobicity or hydrophylicity (tendency to repel or attract water) of the solid product. It has been shown that thermal processing can increase hydrophobicity of biomass, which is beneficial for its longer-term storage (as it does not absorb water). However, there is some evidence that this effect may be only temporary. At present there is little information on the dynamics of the processes responsible for hydrophobicity of thermally treated biomass and therefore this project has a potential to make a significant contribution to knowledge in this area. The main focus will be on study of the processes responsible for hydrophobicity and how these change over time and as a result of different treatments.
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading

centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project: degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Project P083

Title: Crystalline silica-related risks of biochar

Short Description:

Thermal processing of biomass containing high concentrations of silica, e.g. rice husk or rice straw, may result in formation of crystalline forms of silica. This form of silica is known to cause inflammation and respiratory diseases. Both rice husk and rice straw are potentially promising feedstock for power generation and biochar production and therefore assessment of risks involved in use of such materials is very important. Therefore, this project will focus on studying the forms in which silica is present in biochar, as a function of the feedstock and production conditions used. This will involve production of biochar in laboratory units as well as its characterisation using techniques such as (X-ray diffraction) XRD and scanning electron microscopy (SEM).
The project may interest students from a science or engineering background, with interest in sustainability, environment, renewable energy and climate change, and will involve integration of information from a range of disciplines. The project is attached to the UK Biochar Research Centre in the School of Geosciences, one of the leading centres in this field, and will be able to draw on the resources, contacts and expertise of the centre. Due to the experimental nature of the project the student will have an opportunity to acquire important laboratory skills, as well as skills in planning and executing experiments, and collection, analysis and interpretation of data. The student will be encouraged to prepare/ take part on writing a journal publication and/or conference paper as a result of this research and therefore will have the opportunity to learn/ improve skills in academic writing.

Type of project dissertation
Necessary background for the project: degree in engineering or sciences
Additional skills and expertise required for the project:
Ability and willingness to learn new laboratory techniques and to follow established working procedures. Previous experience with working in laboratory environment would be beneficial, but is not essential.

Supervisor Name: David Hogg (Hydrogen Office) and Dimitri Mignard

Project P084

Title: **Economic Analysis of The Hydrogen Office Energy System**

The Hydrogen Office project, based in Methil (Fife), demonstrates the role that energy efficiency, renewables and hydrogen can play in reducing the future impact of climate change and energy security of supply concerns securing our energy supply. The building is powered by a novel renewable and hydrogen energy system, using renewable energy directly when available, whilst storing surplus energy as hydrogen for a proportion of the building's needs for periods where renewables are unable to meet demand. The Hydrogen Office energy system includes a 750kW wind turbine, 30kw electrolyser, 10kW hydrogen fuel cell and a geothermal source heat pump. An electric vehicle charging point is our latest addition.
One of the main areas of The Hydrogen Office that is yet to be fully researched is the economic side of the energy system. Is the system worth the money? What is the production cost of hydrogen? These are questions that would suit a student with both an eye for engineering and an eye for business. The student will gain an insight into the hydrogen market but will need to know how the system works in order to provide an accurate analysis.
Necessary background: A good engineering degree with basic economics, and mastery of the materials taught in the modules: Energy Systems 4; Energy and Environmental Economics; Technologies for Sustainable Energy; Energy Efficiency, Resources and Environment.

Project P085

Title: **Technical Improvements to The Hydrogen Office**

The Hydrogen Office project, based in Methil (Fife), demonstrates the role that energy efficiency, renewables and hydrogen can play in reducing the future impact of climate change and energy security of supply concerns securing our energy supply. The building is powered by a novel renewable and hydrogen energy system, using renewable energy directly when available, whilst storing surplus energy as hydrogen for a proportion of the building's needs for periods where renewables are unable to meet demand. The Hydrogen Office energy system includes a 750kW wind turbine, 30kw electrolyser, 10kW hydrogen fuel cell and a geothermal source heat pump. An electric vehicle charging point is our latest addition.
The Hydrogen Office opened in January 2011. Technology has moved on since. Therefore, there are many new innovations that could be applied to The Hydrogen Office. Not only that but ultimately we would like to be more than an office. The student will be asked to plan and design improvements and upgrades to The Hydrogen Office energy system. Therefore, they will need to do a literature review in both building technology and hydrogen systems. If there is time the student will use The Hydrogen Office's modelling software (in MATLAB/Simulink) to model how these planned improvement s would affect the system.
Necessary background: A good engineering degree with basic economics, and mastery of the materials taught in the modules: Energy Systems 4; Energy and Environmental Economics; Technologies for Sustainable Energy; Energy Efficiency, Resources and Environment.

Supervisor Name: Anup Nambiar

Project P086

Title: Electricity network integration of marine energy in the UK

Short description: To meet the stringent renewable energy targets in the UK, it is envisaged that 2 GW of power from marine renewables will be required by 2020. The variable and stochastic nature of the power generated by arrays and farms of marine energy converters has implications on the performance of the electricity network in the UK.

This project builds upon network integration studies done in the Institute for Energy Systems (IES), and will investigate the effects of arrays and farms of wave and tidal generators, like those that would be seen in the UK waters in 2020/2050. The focus of the work would be to analyse the variations in the power generated by these large farms over different time scales and to match it with the varying demand in parts of the UK network that will see a large penetration of marine renewables. The work will then be used to assess the economic and technological impacts of large farms of marine energy devices in the UK.

Type of project: data analysis, power system analysis, simulation
Necessary background for the project: Electrical/ electronics engineering or similar background
Additional skills and background required for the project: understanding of power system operation and economics

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Project P087

Title: Voltage and power factor control in multi-machine renewable power plants

Short description: In the UK, the best marine renewable resources are found off remote, rural areas where the electricity network is weak. Connecting varying power generation sources, like wave power farms, to such networks will negatively affect the supply voltage quality in these networks. Means must therefore be tested to improve the quality of the supply voltage through excitation control of the connected electrical generators.

At the Institute for Energy Systems (IES), intelligent voltage and power factor control algorithms have been developed to aid the integration of large amounts of power from marine renewables into the electricity network. This project will investigate the application of these intelligent controllers in multi-machine renewable power farms. Different individual and group control strategies will be investigated and the communication requirements between the control elements will be determined. The results from this work will be used to further improve existing voltage/power factor control methods and to explore better network integration of marine renewables.

Type of project: power system analysis, simulation
Necessary background for the project: Electrical/ electronics engineering or similar
Additional skills and background required for the project: knowledge of electrical machines and control

Supervisor Name: Abhinaya Sankaran Iyer (with Gareth Harrison as co-supervisor)

Project P088

Title: Lifecycle analysis of tidal – carbon audit

Short Description: The project will involve creating a database and life cycle assessment for generic tidal devices.

Type of project analytical study, dissertation, techno-economic evaluation of a technology

Necessary background for the project:

Additional skills and expertise required for the project:

Project P089

Title: Assessing long-term demand and supply matching for tidal current energy

Short Description: The study will aim to assess the long term tidal trends and how this can be used to create time-series for power output evaluation

Type of project computer simulation, analytical study, dissertation

Necessary background for the project

Additional skills and expertise required for the project: Competent user of Matlab

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Project P090

Title: Detailed sites characterisation using EMEC ADCP datasets

Short Description: The project will requires using high resolution ADCP datasets to better understand the spatial and temporal variability of the tidal site characteristic for the Fall of Warness site in Orkney.

Type of project analytical study, dissertation

Necessary background for the project

Additional skills and expertise required for the project: Competent user of Matlab

Supervisor Name: Richard Crozier

Project P091

Title: Conversion of magnetic simulation post-processing code from C++ to Matlab/Octave

Short Description:

This is a project to help develop an open source magnetics simulation program. The code for this program and further information is freely available here:

https://sourced.ecdf.ed.ac.uk/projects/see/xfemm/wiki

This program uses code extracted from the open-source program FEMM (www.femm.info). Your task will be to convert some of the code used to perform post-processing of the output of a magnetic simulation solution from the original C++ to Matlab. This is an open source project which is, and will be, used for real research work, and is freely available for anyone to use. You can also point future employers to concrete evidence of your skills embodied in your contributions to this project.

Type of project: Computer Simulation/Software Development

Necessary background for the project: Experience with Matlab or Octave (a free Matlab alternative) is essential. Experience with C, C++ or another sufficiently similar language is essential. You will not be coding in C or C++, but will need to understand it sufficiently to convert to Matlab.

Additional skills and expertise required for the project: Some knowledge of magnetics is desirable but not essential as the results of the algorithms can be compared to the original software. Experience with Subversion (http://svnbook.red-bean.com/) or other software version control systems is desirable but not essential.

Supervisor Name: Dougal Burnett

Project P092

Title: Developing a high resolution solar model for the UK

Short Description: The School of Engineering has in recent years been using a sophisticated numerical weather forecasting model to hindcast wind speeds over the UK and Ireland. It provides hourly wind speed information at 3km resolution and does a very good job at representing historic wind speeds. Many other weather variables such as rainfall, temperature, humidity, insolation, etc., were archived and are intended for use in simulating other aspects of energy generation. This project will use this information to develop a high resolution model of the UK solar resource. A validation process will be performed by comparisons with observations.

Type of project Computer based exercise relying largely on Matlab or equivalent

Necessary background for the project Matlab experience

Additional skills and expertise required for the project: Some statistical analysis

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Project P093

Title: Dynamic Ratings of UK Electricity Transmission System

Short Description: The School of Engineering has in recent years been using a sophisticated numerical weather forecasting model to hindcast wind speeds over the UK and Ireland. It provides hourly wind speed information at 3km resolution and does a very good job at representing historic wind speeds. Many other weather variables such as rainfall, temperature, humidity, insolation, etc., were archived and are intended for use in simulating other aspects of energy generation. This project will use this information to perform a mesoscale analysis of the dynamic ratings of the UK electricity transmission system using wind speed, temperature and other parameters.

Type of project Computer based exercise relying largely on Matlab or equivalent

Necessary background for the project Matlab experience
Additional skills and expertise required for the project: GIS software, ms excel

Supervisor Name: John Pescatore

Project P094

Title: Simulation of Fish Behaviours About Marine Turbine Installations

Short Description: Fish motion is a result of highly complex musculoskeletal activity. Advancement of the state-of-the-art in simulation of free swimming fish near marine turbines is needed to address concerns of the fishing industry and assist in the permitting process for ultimate build-out of such energy production facilities. Some work has been done employing motion control based on fuzzy logic and rather simple fluid models; however, many other research avenues can be taken such as full computational fluid simulation (Eulerian, Lagrangian or a combination thereof); neural-fuzzy approaches with adaptive learning capabilities; simulating multiple fish and/or multiple fish species based on input from experts, and data, etc. Different architectures of artificial neural networks (ANNs) can be used and their only limitation is the creativity of the designer. ANNs can aid in the derivation of fuzzy rules or fuzzy logic can assist in fine tuning ANN parameters.

Type of project: Multidisciplinary in nature, comprising elements of engineering and the biological sciences (Ichthyology) to conduct computer simulation/animation.
Necessary background for the project: Engineering degree (mechanical, electrical, civil) with experience in two or more of the following areas: ANNs, fuzzy logic, IIR filters, numerical methods, computational fluid dynamics.
Additional skills and expertise required for the project:
This effort may be worthy of a doctoral dissertation due to the level of complexity of the problem, and could also involve an additional MSc student and a biology major with an expressed interest in Ichthyology seeking a postgraduate degree (in addition to the lead engineering student) if a heavy CFD approach is chosen.

Project P095

Title: COMSOL Multiphysics Package for Simulation of Specific Marine Turbine Designs

Short Description: COMSOL 4.3A software can import actual designs (AutoCAD, Siemens Solid Edge, etc.) for realistic simulations of marine turbines from different vendors. Adding the latest modules (e.g., fatigue) to the University's existing license (version 4.2) can provide for seemingly limitless MSc projects in the areas of acoustics, heat, fatigue, and CFD on one computing platform with a standardized approach.

Type of project: Computer simulation/multidisciplinary/multiphysics
Necessary background for the project: Particularly suited for mechanical and civil engineers, with some background in computer simulation and FEM.
Additional skills and expertise required for the project: COMSOL training would be particularly propitious. COMSOL offers extensive training seminars, webinars and online resources.

Project P096

Title: An Evaluation of the True Cost of Coal for Power Generation Based on Concepts of "Exergy" for Resource Accounting

Note: See Wall, G. (1999, 2002, etc.) for basic concepts regarding EXERGY

Short Description: When renewable (wind, solar, ocean) sources of energy are compared to fossil fuels, particularly coal – they have inherent cost and reliability negatives - but what is the "true" cost of coal for power production and what "price" must society ultimately pay for it? Moreover, if carbon credits are part of any economic analysis, renewable energy sources begin to look more attractive, although there may still be reliability concerns.

The true cost of coal must take into account all environmental impacts from "mine to stack." U.S. history is marked by catastrophic failures of ash and coal slag impoundments resulting in environmental damage, expensive remediation, fines, legal costs, and, in some cases, loss of life. A fly ash pond embankment failure at the Kingston, TN power plant site in 2008 has cost the Tennessee Valley Authority approximately one (1) billion USD to remediate (yes, a billion dollars!) to date – this cost will be factored into the rate base and ultimately borne by utility customers. To put this cost in perspective, if you had a billion dollars 20 years ago, you could have constructed a 1000 MW coal-fired power plant. Today, a billion dollars still might get you a 500 MW plant.

Environmental devastation at coal mine sites, although directly related to the electrical power generation, is never factored into electrical generation costs, unless the power producer actually owns the mine. Clean-up and remediation (e.g. acid mine drainage) costs at abandoned mines are borne by taxpayers. The Buffalo Creek, West Virginia, coal slurry impoundment dam failure in 1972, and the Massey Energy impoundment collapse in Martin County, Kentucky (2000) are two additional examples where the costs were never fully recouped from mine owners, and taxpayers shouldered the financial burden.

The UK and the continent undoubtedly have their own examples of catastrophic events related to coal usage for electrical power generation. Sadly, mine disasters are seemingly a regular occurrence in China, and in other countries with lax safety standards.

Worldwide, coal fired power plants provide about 40% of all electricity generated. The inexpensive cost of coal means that transportation costs, low thermal efficiencies (around 30 – 45% at most power plants), required pollution control devices and boiler modifications, and legacy ash disposal can be tolerated (economically), thereby making this form of energy production perennially competitive. Moreover, the advent of low emission boiler systems, high performance power systems, integrated gasification, combined cycle and pressurized fluidized bed combustion promise improved efficiencies, useable by-products, and lower emissions all at lower costs to the consumer (USDOE). But will these outcomes be realized, and will continued use of coal relegate renewable forms of energy to an even lower tier in the energy production hierarchy?

Type of project: Techno-economic-environmental evaluation of industry incorporating resource accounting methodolgy for a sustainable society.

Necessary background for the project: Degree in economics, or mechanical, civil or general engineering with coursework in engineering economics. Understanding of the electrical utility industry, power economics, risk and reliability measures, carbon trading etc. would be useful.

Additional skills and expertise required for the project: Understanding of capital (construction) costs, and lifecycle (O & M) for power plants, environmental policy/law, carbon trading/credits. A meticulous researcher is needed to quantify ALL costs associated with coal-fired power plants, to develop an accounting scheme for past environmental damages, water usage, and the carbon footprint associated with coal mining, coal transportation, preparation and handling, running all pollution control devices, ash handling, dust suppression, vehicle cleaning, etc.

The researcher will build upon "EXERGY" concepts and, possibly, develop his/her own formulae taking into account the items mentioned herein and others (possibly including diffuse stack radiation releases from coal-fired power plants). In summary, a "mine to stack analysis" is required with possibly mine closure and ultimate ash disposal costs in order to have a new metric against which renewable forms of energy can be measured. The researcher will evaluate the latest data in new coal-fired technologies to determine if they can deliver what was promised, and how this may affect the long term viability of renewable forms of energy.

End note: Although coal v. renewables was emphasised herein, the project could be expanded to a study of coal, gas, and nuclear v. renewables. For example, if nuclear energy was added to the discussion, then impacts from uranium mining to long term management of waste (spent fuel rods) would be included in the resource accounting analysis. For natural gas, the hydraulic fracturing process (fracking) would come under scrutiny, taking into account water demand, habitat loss, etc.

Supervisor Name: Ozan Keysan

Project P097

Title: Development of a Mobile Phone Application to Detect Speed and Faults of Electrical Machines.

Short Description: Electrical machines emit acoustic and vibration signals when running. The frequencies of these signals mainly depend on the rotational speed of the machine. If the machine has a mechanical or electrical fault, extra frequencies exist in the noise/vibration spectrum. The aim of this project is to develop a mobile phone application to detect rotational speed of a machine by recording sound samples. These samples can also be used to check if the machine is healthy or not. The frequency components in the sample can be detected by applying spectral analysis techniques (e.g. FFT). The output of this research will convert any smart-phone into an electrical machine speed sensor and test unit.

Type of project: Software development followed by experimental verifications.
Necessary background for the project Numerate undergraduate degree.
Additional skills and expertise required for the project: Confidence in involved mathematical manipulation, experience of or willingness to engage in software development (e.g. Java, Linux). Students interested in this project are advised to discuss it with Ozan Keysan (o.keysan@ed.ac.uk) before making their decision.

Project P098

Title: Comparison and Control of Power Take-off Systems for Combined Wind/Wave Energy Platforms.

Short Description: This project will investigate different power take-off (PTO) systems and control strategies for a combined wind/wave energy platform. The operating conditions will be supplied for various wind/wave energy converters at different sea states. The aim of this project is to develop a generator rating methodology for a single generator unit or separate generator units. Different PTO options will be compared in terms of the power quality and the reliability. Good mathematical modelling will be required and knowledge of Matlab (or R) will be beneficial. Results of this work will contribute to the European MARINA-Platform project which is investigating combined ocean energy platforms.

Type of project Analytical study, computer simulation
Necessary background for the project Degree in Electrical and/or Electronics is preferable, but other degrees (e.g. Mechanical) are also applicable.
Additional skills and expertise required for the project: Knowledge of statistics and programming will be helpful. A basic understanding of electrical machines is necessary.

Supervisor Name: Istvan Gyongy
Note: David Forehand has kindly volunteered to co-supervise this project, as he supervised a similar project last year

Project P099

Title: Simulation, Visualisation and Animation of Waves in the New Circular Wave Tank

Short Description: A new, multi-million pound circular wave tank is under construction at Edinburgh University for the testing of marine energy devices (http://www.flowavett.co.uk). The tank features an array of wavemaking paddles around the perimeter, which allow waves to be generated in any direction, and hence complex sea states to be reproduced. So far, computer simulations of wave generation in the tank have yielded steady-state oscillatory results (i.e. frequency-domain results). The proposed project would build on these outputs, and would consider how this frequency response data may be transformed into the time domain (using existing theory) so that transient effects may be looked at.

Type of project Computer simulation

Necessary background for the project Any field in Engineering

Additional skills and expertise required for the project: Matlab skills, and some knowledge of Hydrodynamics are useful, but not necessary

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Project P100

Title: Real-Time Analysis of Driving Style to Reduce Fuel Consumption

Short Description: Whilst advances in car design have resulted in improved fuel efficiency, the driver's driving style still plays a large part in determining the levels of fuel consumption and greenhouse gas emission seen in practice. In particular, significant fuel savings may be obtained by driving less "aggressively". Starting from a simple dynamic model for a car, this project will use computer simulations to investigate whether the "eco-friendliness" of the driver may be assessed using inertial sensors in the vehicle (e.g. those in a smartphone). The potential of generating real-time, in-vehicle feedback will be considered.

Type of project Computer simulation

Necessary background for the project Any field in Engineering

Additional skills and expertise required for the project: Matlab skills are useful but not necessary

Supervisor Name: Adam Robinson

Flow conditioning for use in current and wave testing tanks (Two Projects)

The University of Edinburgh is in the process of building the first 3D combined current and wave test Facility (www.flowavett.co.uk). The tank is the first of its Kind and will be used to test scaled offshore energy converters and structures such as arrays of tidal turbines.

The Facility is a tank of 30 metres diameter and 6 metres deep featuring 160 absorbing wave makers. Water can simultaneously and independently be pumped across the tank in any direction, with maximum current velocities of 0.8metres per second.

Project P101

Project 1: An investigation of the switching screens to achieve improvements in performance and reduce energy use. Screens are porous walls placed in the flow path to reduce turbulence; the downside is they slow the flow and use energy. Switching screens can be removed from the flow path quickly when required.

The project will involve design and manufacture of switching screens then fitting to an existing experimental flume setup then analysing the energy loss and wake effect of this setup. Flow measurements will be taken using an Acoustic-Doppler Velocimeter.

Project P102

Project 2: the use of flow conditioning to flatten the velocity profile caused by conditioned propellers. This project will look at using variable porosity flow conditioning to control the propeller wake and assess the energy cost of this action. The effects of the variable porosity flow conditioning will be measured using an Acoustic-Doppler Velocimeter mounted on an automated gantry.

Supervisor Name: Barry Hayes

Project P103

Title: 100% Renewable Electricity Generation in Scotland: Grid Integration Requirements and Challenges

Short Description: Scotland has set very ambitious targets for renewable energy, aiming to generate 100% of its electricity from renewable sources by 2020. Wind generation (onshore and offshore) is expected to make up by far the largest contribution to this target. The variable nature of the wind resource creates huge challenges for the planning and operation of the transmission grid, particularly around the management of network constraints, and the provision of both positive and negative system reserve.
This project will build on previous work at the Institute for Energy Systems (IES) on wind resource and power system modelling, to create a detailed "2020" model of the Scotland's electricity grid, including all current and future (i.e. planned/under construction) wind plant. This model will allow the power flows across key system boundaries to be examined in detail for a range of operational scenarios (e.g. low wind output/high electricity demand, high wind output/low electricity demand). The effect of very high penetrations of wind on transmission network constraints and the requirements for additional system reserve, or "flexibility", to manage network congestions will be quantified in detail.

Type of project: Power system analysis and simulation, wind resource assessment.
Necessary background for the project: Electrical/power engineering.
Additional skills and expertise required for the project: General understanding of power transmission networks and wind energy systems.

Project P104

Title: Reliability Models of Onshore and Offshore Wind Farms for Power System Analysis

Short description: Wind energy systems present unique modelling challenges due to the inherent variability in the wind resource. In order to fully understand the impacts of wind generation on the reliability of the power system, it is necessary to build probabilistic models of wind generation systems, which are able to represent the statistical and temporal variations in the wind resource, and also the failure rates of the wind turbines (e.g. [1]-[3]).
This project will use existing wind measurements to create models of the UK onshore and offshore wind energy resource (using the Markov Chain or ARMA method, or similar). These will then be combined with estimates of the failure and repair rates of typical UK wind turbines, to build equivalent wind farm models, which characterise both the availability of the wind resource, and the performance/reliability of the turbines. These models are particularly useful for assessing the reliability of power systems with large amounts of onshore and offshore wind generation.

[1] Castro Sayas, F.; Allan, R.N.; , "Generation availability assessment of wind farms," Generation, Transmission and Distribution, IEE Proceedings- , vol.143, no.5, pp.507-518, Sep 1996.
[2] Billinton, R.; Yi Gao; , "Multistate Wind Energy Conversion System Models for Adequacy Assessment of Generating Systems Incorporating Wind Energy," Energy Conversion, IEEE Transactions on , vol.23, no.1, pp.163-170, March 2008.
[3] Dobakhshari, A.S.; Fotuhi-Firuzabad, M.; , "A Reliability Model of Large Wind Farms for Power System Adequacy Studies," Energy Conversion, IEEE Transactions on , vol.24, no.3, pp.792-801, Sept. 2009.

Type of project: Modelling and simulation, data analysis.

Necessary background for the project: Electrical and/or mechanical engineering.

Additional skills and expertise required for the project: Basic programming in Matlab or similar software.

Supervisor Name: David Ingram

Project P105

An Economic Assessment of a Combined Wind-Wave Ocean Energy Platforms

The European FP7 Project Marina-Plartform is looking at maritime, deep water platforms, which combine wind and wave energy on a single floating platform. The basic idea is that by combining floating wind and wave energy infrastructure can be shared and costs reduced. The MARINA-Platform project has identified three concepts for further study and modelling and this MSc project will investigate the economics of one of these in detail. Using the GIS systems developed by the University of Edinburgh, based on 10 years of hindcast data from NKUA, sites will be selected for deployment and design conditions identified. Working from an initial outline of the platform the likely levelised cost of energy will be computed and an ecconomic assessment made.

Project P106

Model testing of a Combined Wind-Wave Ocean Energy Platforms

The European FP7 Project Marina-Plartform is looking at maritime, deep water platforms, which combine wind and wave energy on a single floating platform. The basic idea is that by combining floating wind and wave energy infrastructure can be shared and costs reduced. The MARINA-Platform project has identified three concepts for further study and modelling and this MSc project will investigate one of these in detail. Using the GIS systems developed by the University of Edinburgh, based on 10 years of hindcast data from NKUA, sites will be selected for deployment and design conditions identified. Most of the existing concepts in Marina are based on heaving wave energy converters and the study will initially consider replacing these with surge converter. Building on the design conditions the structural design of the platform will be outlined and basic hydrodynamic model constructed, model testing of the platform should be conducted at the end of the project.

Project P107

CFD modelling of Tidal turbines in arrays

This project will consider the modelling of small arrays of tidal turbines in the Sound of Islay. A computational fluid dynamics model will be constructed using the EDF CFD code Code_Saturne with the BEMT-AD model built in the PERAWAT project being used to model the rotors. CFD simulations will be run on the National HPC computer HECToR and an analysis of the interaction of the rotor wakes performed. The BEMT-AD model uses a simple description of the rotor using the blade geometry and the aerodynamic coefficients of the blade sections, The University of Edinburgh has data for a generic full scale turbine, but the project should investigate modelling the 1MW Hammerfest-Strom rotor being deployed in the Islay Sound Project.