

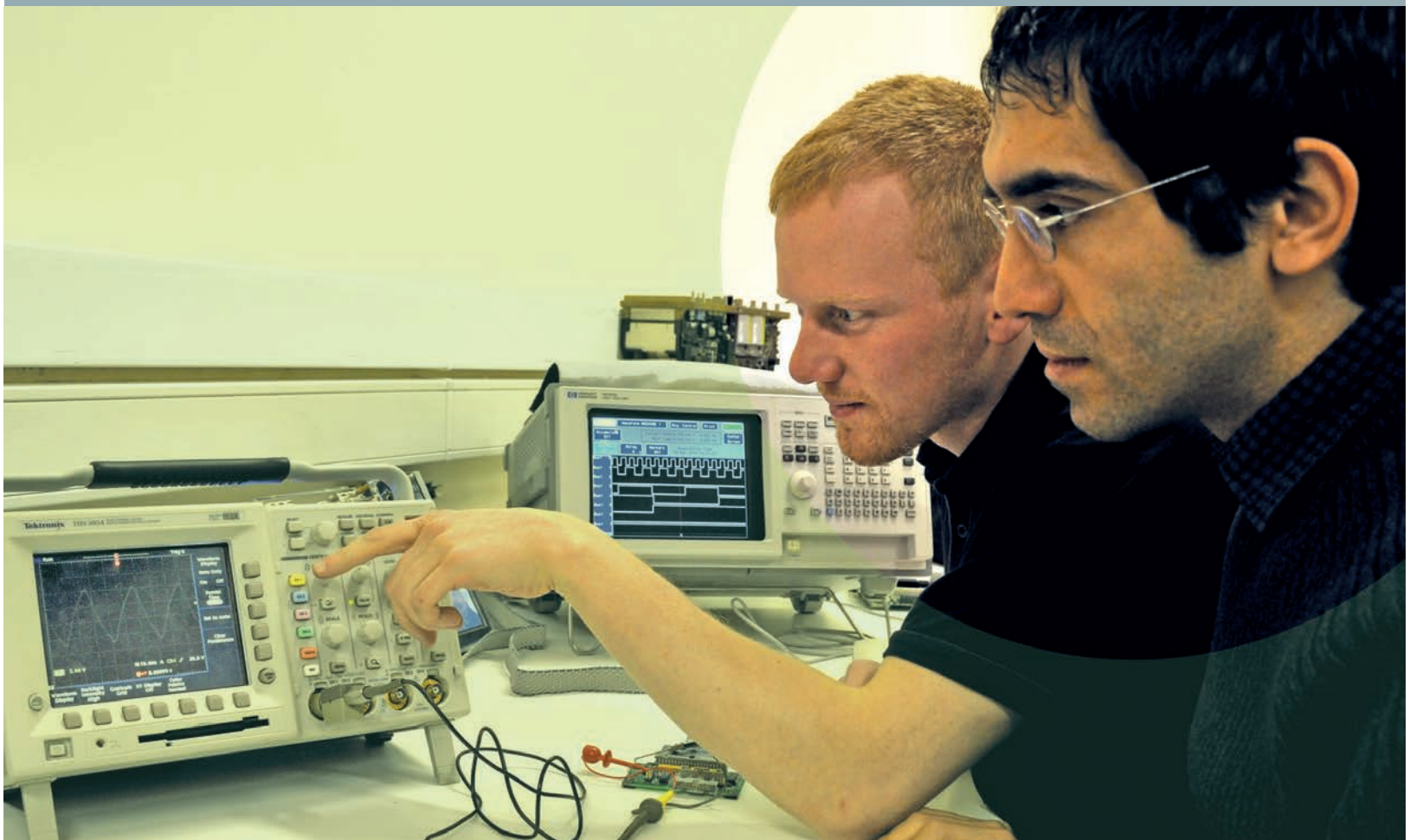
# School of Engineering



UNIVERSITY  
OF ABERDEEN

Electrical and Electronic Engineering

EEE  
Research





# INTRODUCTION

Electrical and Electronic Engineering (EEE) is one of five main disciplines within our School of Engineering. The school contains award-winning staff and modern, well-equipped laboratories and is supported by excellent workshops and laboratories dedicated to particular areas of work. The EEE Research Group seeks to advance fundamental knowledge and promote applications across the whole spectrum of activities in topics relating to electrical and electronics.

**INTERNET ENGINEERING** - Our Internet Engineering group focusses on new transport technologies for the modern Internet. World-leading research in Aberdeen is currently playing a key role setting new standards for the Internet. Communications engineering features in undergraduate EEE courses, where students learn the design principles of connecting equipment to a network, the use of networks to remotely control equipment and the operation of networking devices.

**LASER APPLICATIONS** - The School has state-of-the-art laser facilities. There has been research in optical engineering for the last thirty years. An extensive set of lasers, photographic processing and hologram replay facilities are used for experiments ranging from the welding of dissimilar materials to volume sectioning using the world's largest dual orientation holographic camera. This equipment supports both teaching of EEE students and research projects.

**ELECTRONICS RESEARCH** - Research extends from simulation and analytical work to the construction of new prototype equipment and field testing. The research laboratories and workshop facilities support the applications of microcontrollers, video transmission and applications of remote sensing. Undergraduate students may be given the opportunities to explore new designs or to work with researchers in exploring a particular research problem.

**POWER ELECTRONICS** - In undergraduate programmes, students learn the design principles of electrical systems, power electronics and the operation of transmission equipment. Internationally leading research in power electronics includes integration of large renewable power parks with DC networks that include DC/DC converters. Point to point High Voltage Direct Current (HVDC). Thus research is essential for enabling development of new renewable energy sources such as offshore wind farms.



*All staff  
teach on our  
undergraduate  
EEE degrees*

## EEE STAFF

Prof Gorry Fairhurst  
Prof Dragan Jovcic  
Prof John Watson (Emeritus)  
Dr Khaled Ahmed  
Dr Sumeet Aphale  
Dr Masood Hajian  
Dr Kaliyaperumal Nakkeeran  
Dr Raffaello Secchi  
Dr Andy Starkey  
Dr Thanga Thevar  
Dr Fabio Verdicchio

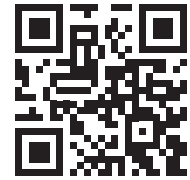
# INTERNET ENGINEERING

## A New Evolutive API AND Transport-Layer Architecture for the Internet (NEAT)

Funding organisation: EUROPEAN COMMISSION H2020

Investigator: Gorry Fairhurst

[www.neat-project.org](http://www.neat-project.org)

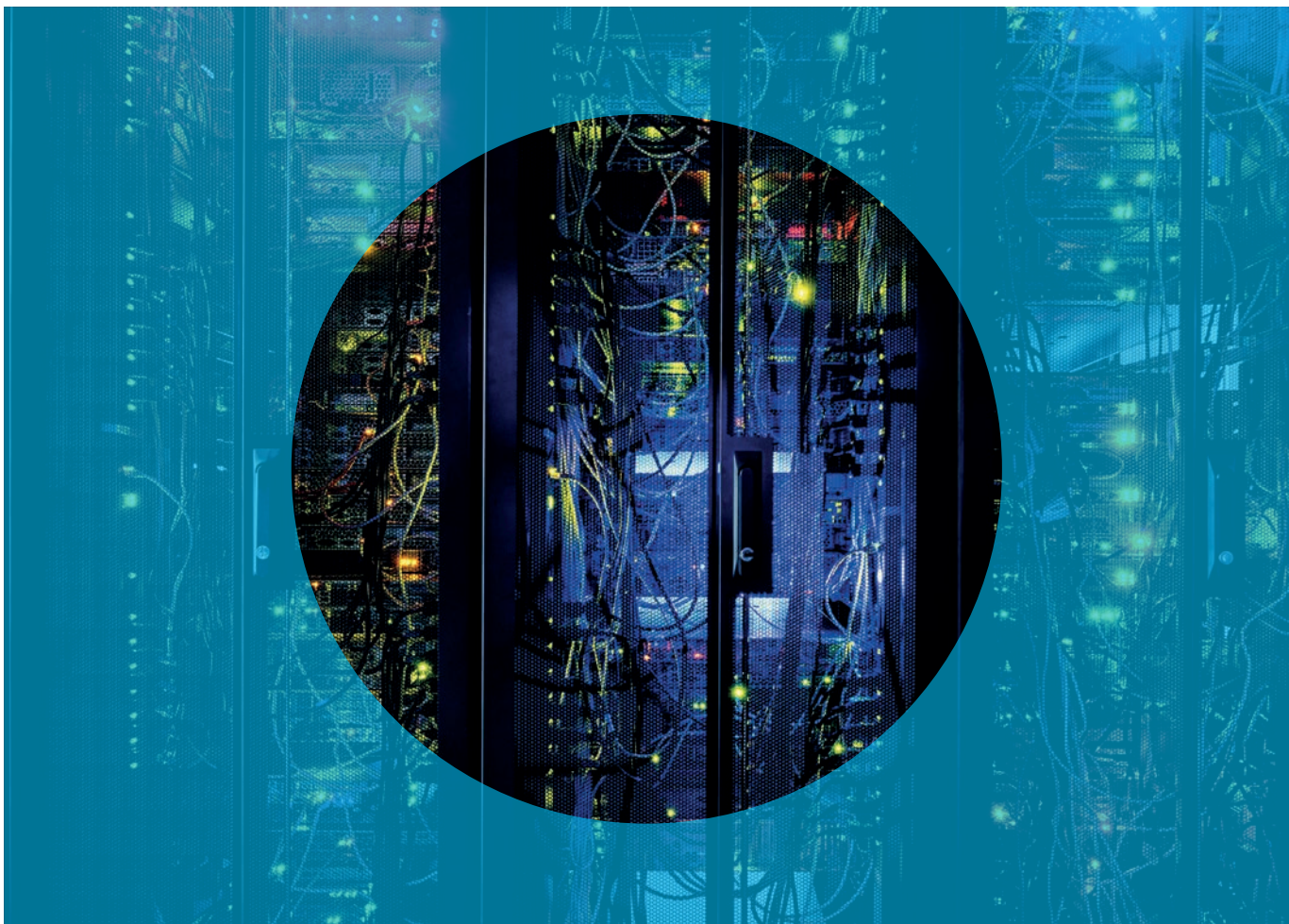


The value of the Internet comes from the applications that can be used across the network. It is therefore perhaps somewhat surprising that, after decades of vast improvements to the infrastructure and development of countless innovative applications on top of this that the “interface” that application programmers use to access the Internet has changed very little since the 1980’s.

NEAT is a 36 Month European Union research project that is researching how to redefine the interface between the Internet applications and the network. The work is led by a consortium of top industry players and leading academic centres (SRL, Mozilla, EMC, Cisco, University of Aberdeen, University of Oslo and Karlstads University). The new open-source interface will allow Internet

applications to be dynamically tailored to network capabilities (without them needing to be updated each time Internet technology changes). This is expected to lower the barrier to innovation and enable new applications to quickly adapt as the Internet technology continues to evolve.

*The new free open-source interface will allow Internet applications to be dynamically tailored.....*



## Measurement and Architecture for a Middle boxed Internet (MAMI)

Funding organisation: EUROPEAN COMMISSION H2020

Investigator: Gorry Fairhurst

<https://mami-project.eu>



*The project seeks to restore  
the balance among  
end-user privacy  
and network*

Recent revelations about large-scale surveillance of Internet traffic have led to expanding use of encryption to protect people's privacy. At the same time, emerging applications make new demands on the way the Internet is designed, motivating network operators to introduce new network functions to support ever more demanding applications. These two trends are set on a collision course.

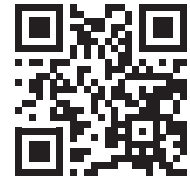
The University of Aberdeen joins ETH Zürich and other partners in a project that will re-architect the Internet to enable explicit cooperation between networking equipment and user applications. This seeks to restore the balance among end-user privacy concerns in the face of pervasive surveillance, stimulate innovation in network protocols, and the enable network operators to provide new in-network functionality.

## The Satnex IV Network of Experts

Funding organisation: EUROPEAN SPACE AGENCY

Investigator: Gorry Fairhurst

[www.satnex4.org](http://www.satnex4.org)



The Satellite Network of Excellence, SatNEx, was formed in 2004 by 22 partner research organisations and universities. The project was coordinated by the German Aerospace Centre (DLR), with the support of the European Union research programme. SatNEx had the goal to create a critical mass of research in advanced satellite communications, to harmonise research across Europe, and to provide a resource of knowledge for European industry.

Since 2009, the SatNEx has been supported by the European Space Agency, from their technology research centre in Noordwijk in the Netherlands. Within the network, the University of Aberdeen has developed standards for broadband satellite, cross-layer protocol techniques, evaluation of web applications via satellite and led the activities on the role of satellite in the Future Internet.



*The University of  
Aberdeen has developed  
standards for  
broadband satellite*

## SMILE

Funding organisation: Thales Alenia Space, Toulouse

Investigators: Gorry Fairhurst & Raffaello Secchi



The School of Engineering plays a key role in setting new transmission standards for satellite that enable convergence with TV broadcasting over the Internet. Current research focuses on adaptive multimedia transport and techniques to enable greater flexibility for next generation TV services.

This work is funded by Thales, Toulouse, where the University brings satellite networking expertise to a wider project that will build a technology demonstrator for the French Space Centre (CNES).

## Rural PAWS and the RCUK Rural Digital Economy Research Hub

Funding organisation: RCUK

Investigators: Gorry Fairhurst & John Farrington (Geography)

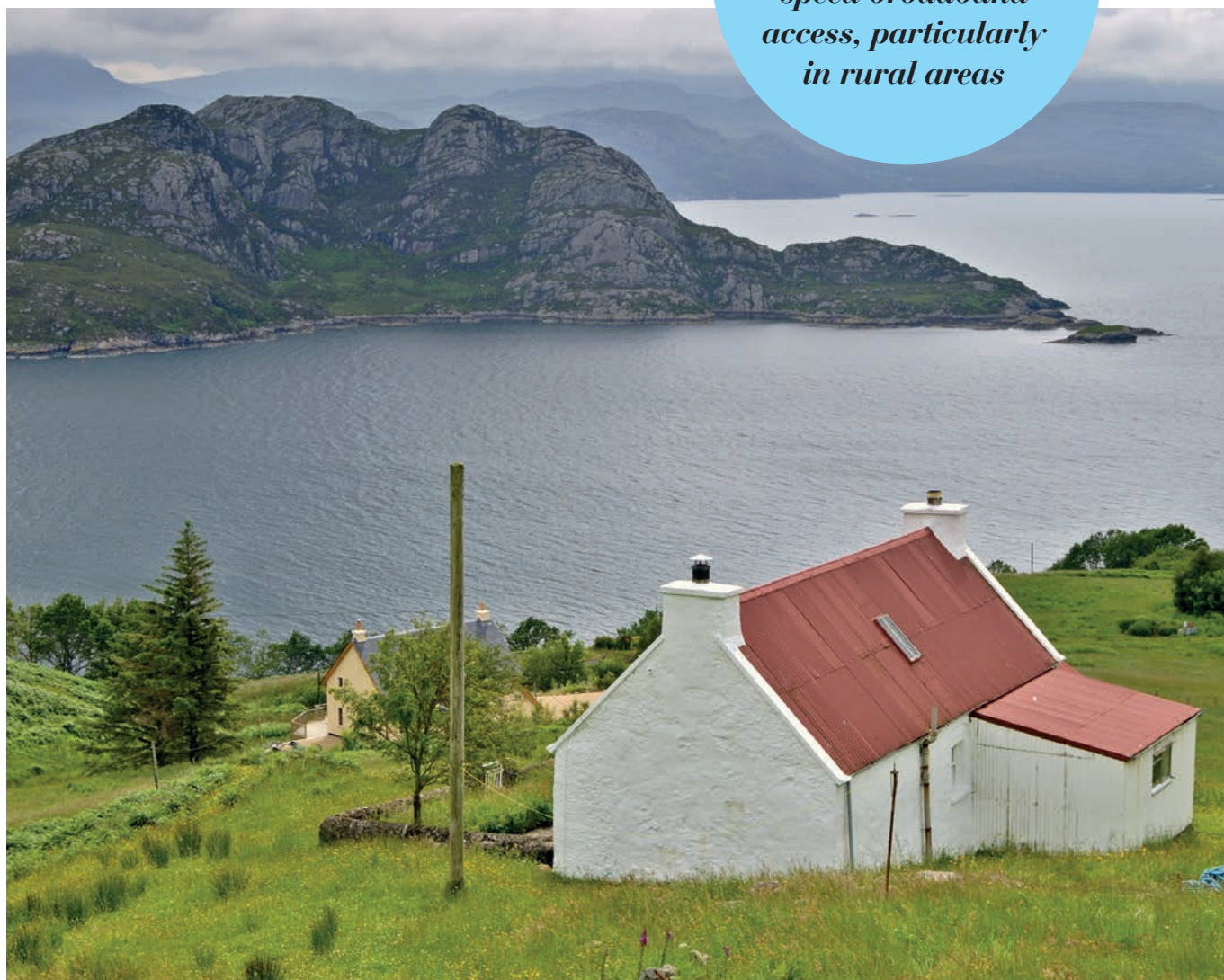
[www.dotrural.ac.uk](http://www.dotrural.ac.uk)



The Internet lies at the core of modern society. It is often thought about as a critical resource, much the same as water or electricity. Yet, many people in the world still struggle to get high speed broadband access, particularly in rural areas. A research team in the School of Engineering has led Internet Engineering activities in the piloting new technology to deliver pay-per-use TV and broadband satellite access to the creative industries. The projects have supported high speed connections to farms, home and linking arts and venues with high quality video, providing Internet connectivity for people in rural hard to reach locations.

This work was supported by the Rural Digital Economy Hub at the University of Aberdeen which was funded as an £11.8 million hub project through themes and projects targeted at key economic activities in the rural UK.

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# POWER ELECTRONICS - EXAMPLE PROJECTS

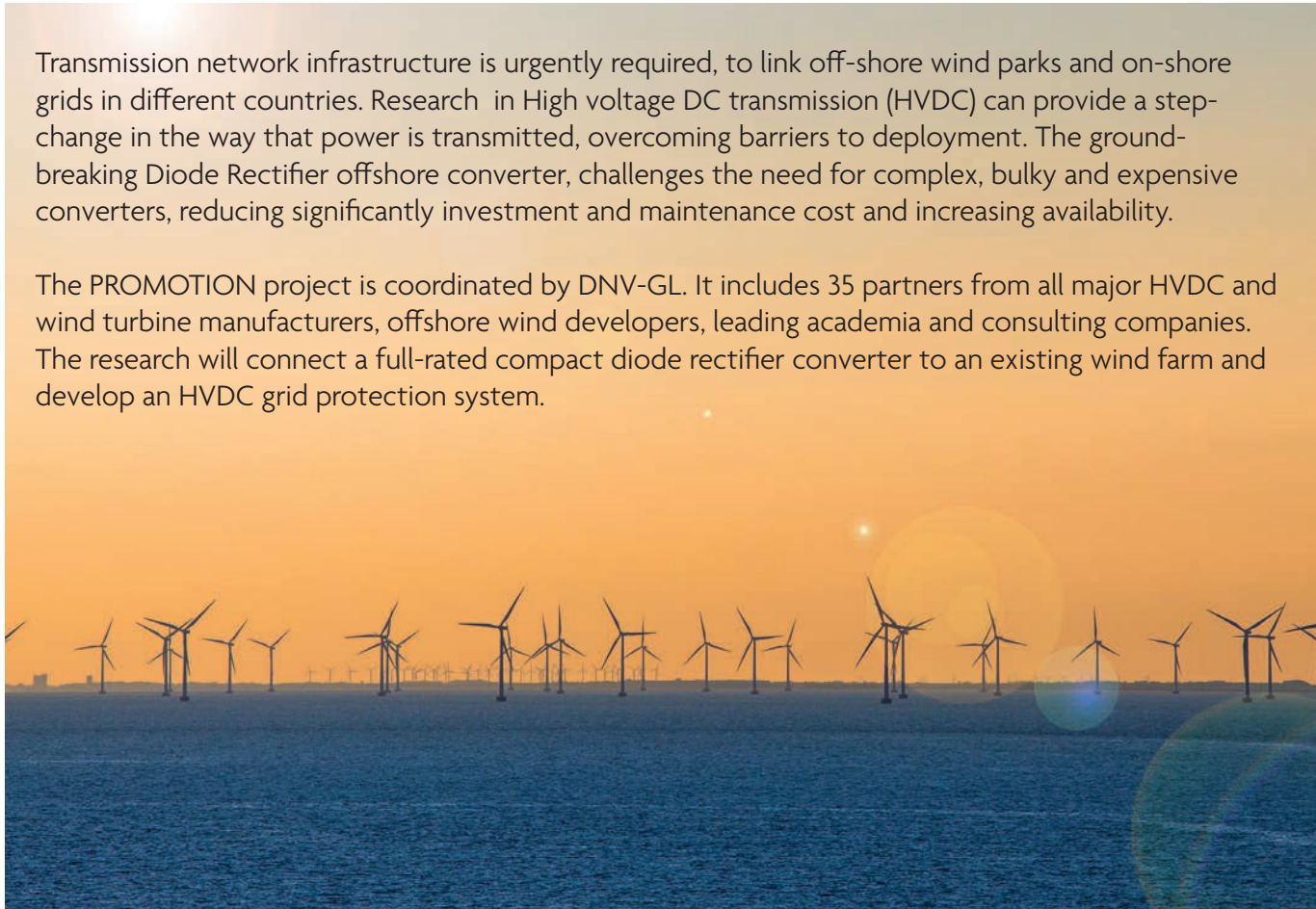
## **Progress on Meshed HVDC Offshore Transmission Networks (PROMOTION)**

Funding organisation: EUROPEAN COMMISSION

Investigator: Dragan Jovcic

Transmission network infrastructure is urgently required, to link off-shore wind parks and on-shore grids in different countries. Research in High voltage DC transmission (HVDC) can provide a step-change in the way that power is transmitted, overcoming barriers to deployment. The ground-breaking Diode Rectifier offshore converter, challenges the need for complex, bulky and expensive converters, reducing significantly investment and maintenance cost and increasing availability.

The PROMOTION project is coordinated by DNV-GL. It includes 35 partners from all major HVDC and wind turbine manufacturers, offshore wind developers, leading academia and consulting companies. The research will connect a full-rated compact diode rectifier converter to an existing wind farm and develop an HVDC grid protection system.

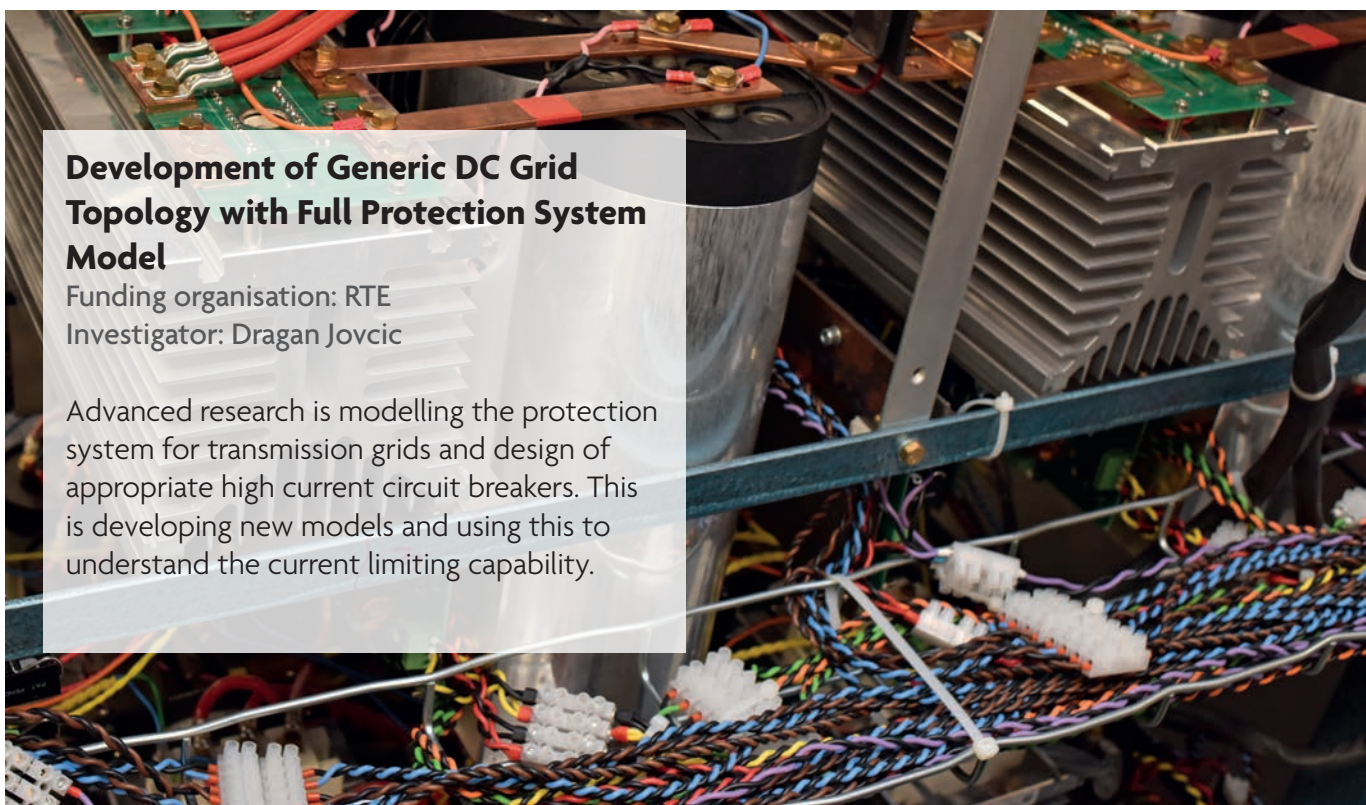


### **Development of Generic DC Grid Topology with Full Protection System Model**

Funding organisation: RTE

Investigator: Dragan Jovcic

Advanced research is modelling the protection system for transmission grids and design of appropriate high current circuit breakers. This is developing new models and using this to understand the current limiting capability.





## DC Networks with DC/DC Converters for Integration of Large Renewable Sources

Funding organisation: EPSRC

Investigators: Dragan Jovicic & Khaled Ahmed

Both the UK and China have enormous wind power potential which theoretically can exceed total national energy demand. Much of this energy is located offshore or in remote sites, with no electrical grid or very weak grid infrastructure. These factors together with the variability of wind energy result in integration challenges, and demand new approaches in developing transmission/collection grids.

The project investigates development of DC grids by considering the essential requirements based on AC systems experience, like security, stability, reserve, fault responses loss minimization. To meet these requirements we explore electronics DC/DC components and consider also semiconductor-based DC CB and mechanical DC CB. DC/DC converter designs will be based on flexible power electronics. This controllability enables them to also take on a range of other functions.

### High-Power DC/DC Converter and DC Hub Based on Modular Multilevel Topologies

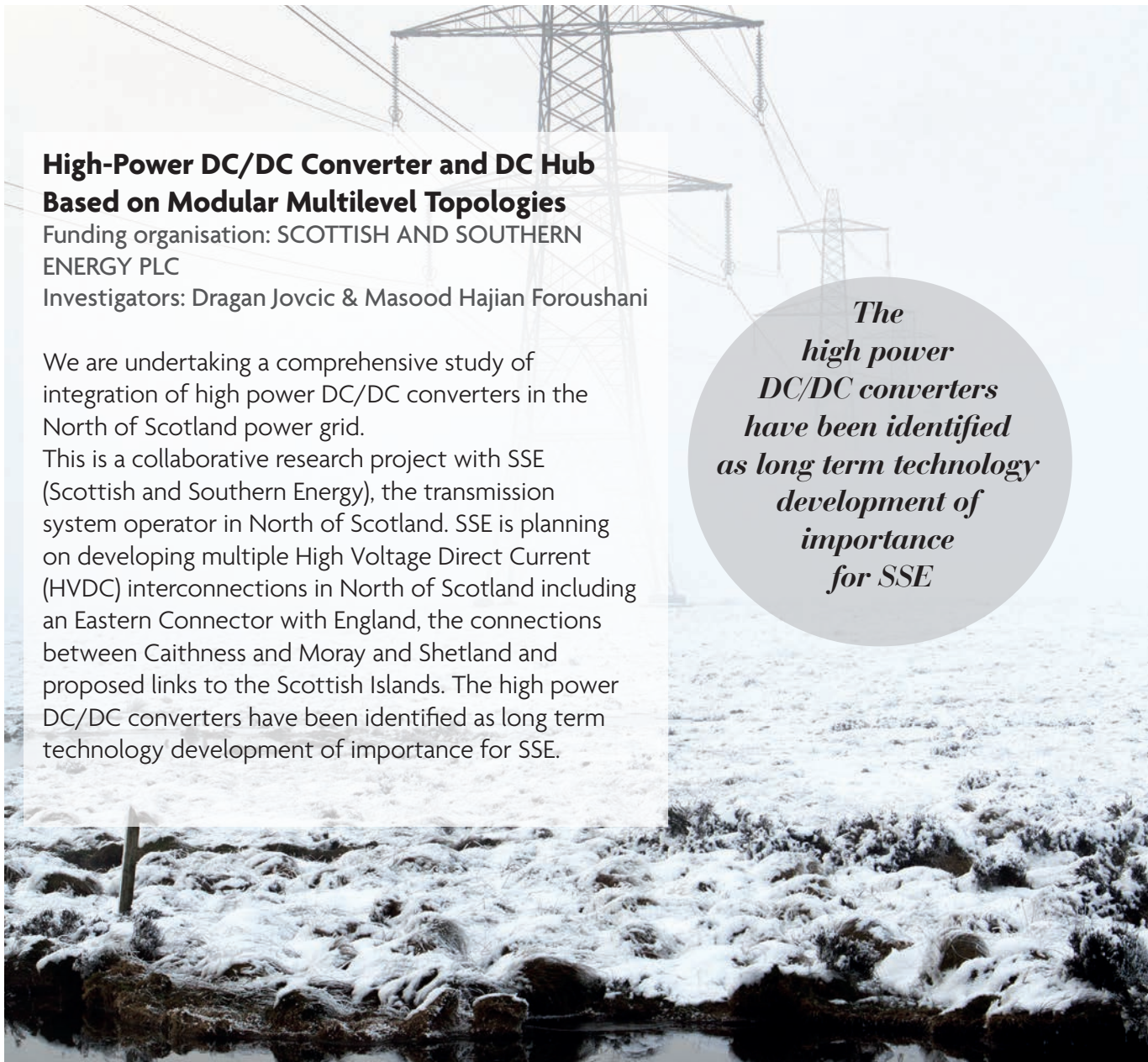
Funding organisation: SCOTTISH AND SOUTHERN  
ENERGY PLC

Investigators: Dragan Jovicic & Masood Hajian Foroushani

We are undertaking a comprehensive study of integration of high power DC/DC converters in the North of Scotland power grid.

This is a collaborative research project with SSE (Scottish and Southern Energy), the transmission system operator in North of Scotland. SSE is planning on developing multiple High Voltage Direct Current (HVDC) interconnections in North of Scotland including an Eastern Connector with England, the connections between Caithness and Moray and Shetland and proposed links to the Scottish Islands. The high power DC/DC converters have been identified as long term technology development of importance for SSE.

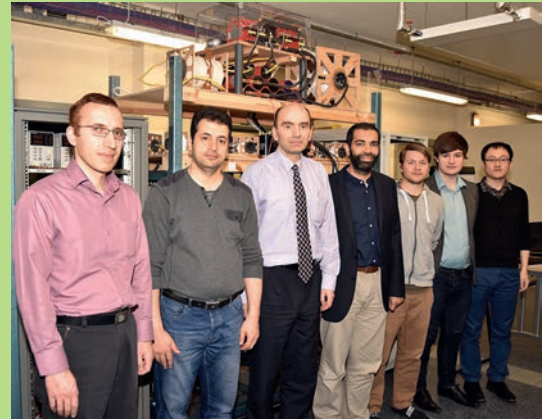
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## Circuit Optimisation for Multi-Infeed HVDC Systems

Investigators: Jovic Dragan & Ahmed Khaled

This research project is the result of industry collaboration, the transmission system operator in North of Scotland. Research into new technologies for an offshore DC grid is an essential part of long term DC development. The project is providing a comprehensive study of the North of Scotland power grid to identify technical challenges and opportunities for optimisation and control.



## Power Electronics Applications Laboratory for Research Activities

Funding organisation: ROYAL SOCIETY

Principal investigator: Khaled Ahmed

Offshore wind farms have been rapidly expanding in Europe and are set to become the main source of renewable energy in Scotland in future years. This has driven demand for high power/voltage DC/DC converters.

A fully new modular DC/DC converter suitable for wind energy applications will be presented. This architecture has the potential for step up or step down of the transmission voltage and transfer of the required power. The design will utilise cascaded connection of converters to achieve higher power ratings. This enhances the overall system fault tolerance. A low voltage and power scaled prototype will be implemented to provide the feasibility of the proposed converter. The key features are higher reliability, lower cost, smaller volume and ease of replacement and upgrading.

## Micro Wind Turbine

Funding organisation: SCOTTISH FUNDING COUNCIL

Investigator: Khaled Ahmed

Capture Mobility Ltd has developed a hybrid micro wind turbine to harvest the turbulence of passing by traffic. This can be placed by the side of highways to harvest the turbulence of traffic. The solar petals on top of turbine are couples that also rotate and produce extra energy. The School of Engineering team will enhance the efficiency of the turbine. The project will identify methods to remove pollutants from the environment using the turbine movement and propose materials that could be integrated with the turbine to effectively capture the carbon particles from the air.



# ELECTRONICS RESEARCH - EXAMPLE RESEARCH PROJECTS

## **Studying Fox Dens and Moose Carcasses in Arctic Conditions with an Intelligent Camera Trap**

Funding organisation: SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCE

Investigators: Gorry Fairhurst & Fabio Verdicchio

Digital cameras enable remote recording of high quality imagery - both still images and video content. Advanced coding methods detected and compress relevant imagery. The platform was deployed in the Cairngorns using solar-powered, low-cost satellite networking to provide remote access to the isolated location. This flexible approach represents a new paradigm for collecting environmental data enhancing accuracy and quality, with the potential to revolutionize data collection.

Joint research between the University of Aberdeen and Grimsö Research Station, Swedish University of Agricultural Sciences, Sweden has allowed the design of an autonomous camera. A set of ten cameras were produced in the electronics workshops at the School of Engineering, with software developed by staff and students. The final software has been made available as open source.



## Smartsense: Autonomous Monitoring of Rail Infrastructure

Funding organisation: NETWORK RAIL

Investigator: Fabio Verdicchio

Recent technological advancements in sensors, processors and communications technology make it viable to perform digital acquisition of environmental data from remote locations. This project explores how these advances can address challenges in remote monitoring of the rail infrastructure. NetworkRail has identified scenarios where a monitoring system is required to be deployed at short notice and must operate autonomously for weeks, without mains power or dedicated communication links.

Examples are:

- Level-crossing misuse: to alert control centres or trains of potentially dangerous behaviour.
- Trespassing and/or vandalism: to detect and record unlawful accesses to facilities.

*NetworkRail  
has identified  
a set of scenarios  
where innovative  
technology can be  
deployed*



## Data and Image Processing of Digital Holograms

Funding organisation: DEFENCE SCIENCE TECHNOLOGY LABORATORY

Investigators: Thanga Thevar & John Watson

Leading holographic techniques and advanced optoelectronics feature in the School of Engineering undergraduate and postgraduate activities. Digital holography has been growing in importance over the last fifteen years or so for sizing of microscopic particles. This provides a unique way of in-situ imaging and non-destructively monitoring the water column and studying species and their interactions at high-resolution and in 3D. The holograms can be

analysed to monitor the x,y,z coordinates of individual organisms and their spatial relationships with each other. Holographic video can make it possible to extract time-dependant information. A single holographic video may contain as much as 2 GB of data: processing this rapidly is a challenge. Techniques include both hardware solutions such as incorporation of Field-Programmable Gate Arrays (FPGAs), multi-processor systems and software solutions.

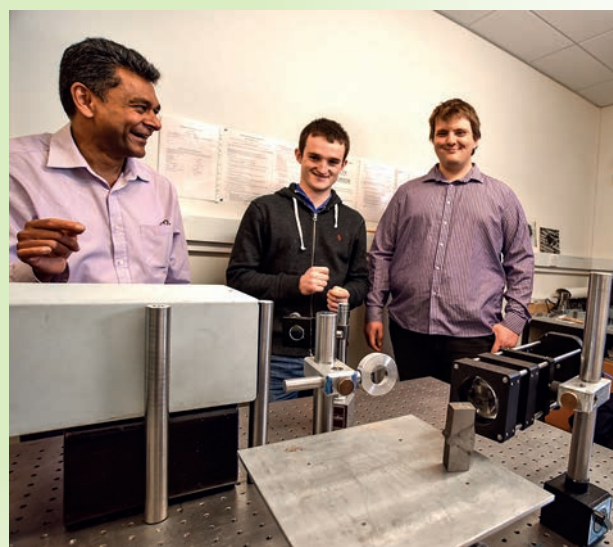
*This brings together  
the leading European  
research institutions*

## STRONGMAR

Funding organisation: EUROPEAN COMMISSION

Investigators: Thanga Thevar & John Watson

STRONGMAR (Strengthening Maritime Technology Research Centre) is a project funded under the Twinning program to create a collaborative and productive link in the global field of marine science and technology. This brings together the leading European research institutions: INESC-TEC (PT-Coordinator), University of Aberdeen (UK) Heriot-Watt University (UK), NATO Science Organisation (BE), University of Girona (ES), and CINTAL(PT). This will establish a programme of summer schools; scientific meetings; and enable long-term staff visits; conferences; technology; and other activities.



## Subsea Holographic Camera (eHoloCam) for Japan Trials

Funding organisation: University of Tokyo

Investigator: John Watson & Thanga Thevar

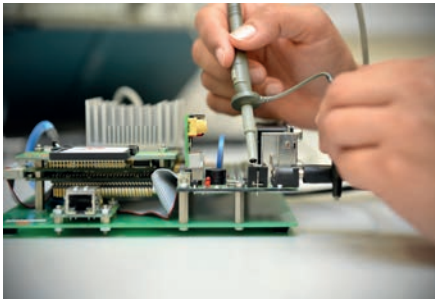
eHoloCam is a design of subsea holographic camera, based on electronic recording and replay of the holographic images. This is the latest in a long series of holographic cameras developed for the analysis of plankton and other subsea organisms. This unique design uses a pulsed laser to allow capture of fast-moving organisms. The holocamera combines ease of use and adaptability for mounting on subsea observation platforms or towing frames and will be able to record water volumes of around 50 cm<sup>3</sup>.

Current funding from the Institute of Industrial Science at the University of Tokyo is supporting a loan of eHoloCam to the University of Tokyo experiments. The holocamera is being deployed to depths of 2000m in the seas around Japan.



# Study EEE at the University of Aberdeen

## Undergraduate degrees



- MEng/BEng Electrical and Electronic Engineering
- MEng Mechanical and Electrical Engineering
- MEng/BEng EEE with Renewable Energy
- A joint programme with computer science leads to a MEng Electronic and Software Engineering

All honours programmes accredited by the Engineering Institutions. Most EEE graduates go on to work in industry (related to the energy sector, either locally or in UK abroad, and/or in other EEE sectors, e.g. networking, comms, electronics/computing systems).

**The teaching programmes** reflect the 'systems engineering' approach in modern industry, with a philosophy of world-class teaching in an atmosphere of internationally-leading research. This general engineering approach ensures understanding of the fundamentals of engineering, and enable graduates to be versatile and efficient in interdisciplinary team/projects.

**Years 1 and 2** of study lay a foundation of basic and advanced electrical and electronic engineering. Specialist skills are acquired in the following years when students have a choice of advanced electrical and/or electronics courses.

**Laboratory sessions** provide hands-on experience with hardware and software tools, complimented by engineering design activities. All students complete an individual project, usually linked to current research or to our portfolio industrial collaboration.

## Postgraduate degrees

In the school we also offer a portfolio of MSc degree programmes covering a range of Engineering specialisms.

Postgraduate research students have the opportunity to undertake research at a range of levels, through either full-time or part-time study leading to an MSc by Research, MPhil, PhD or an EngD (a professional Engineering doctorate).


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