Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

TCD Sustainability Research Awards and Projects – May 2020

School of Natural Sciences

PI	Matt Saunders
Project Name	SmartBog: Smart observations of management impacts on peatland function
Funder	Environmental Protection Agency
Value	€500,000
Length	48 months
Contract Signed	13/12/2018
Details	The SmartBog project assesses the impacts of anthropogenic management activities, such as drainage, on the greenhouse gas (GHG) emissions and removals from peatland ecosystems. The project will utilise earth observation data from COPERICUS satellite products and near-earth high resolution imagery to identify drainage features and to assess drainage status and peatland habitat across Ireland. From this assessment a series of sites across a drainage gradient will be selected to measure both land-atmosphere, and fluvial carbon and GHG emissions. The latter aspect is of particular importance as these losses can be significant but are generally not reported in the net GHG assessment of terrestrial ecosystems. The point source GHG measurements will also be undertaken at two verification sites equipped with eddy covariance towers to enhance spatial up-scaling and emission reporting from peatland land cover classes. In addition, an Internet of Things (IoT) sensor platform will be established at each site to provide real-time environmental variables used to interpret/predict GHG fluxes and verify EO data. The outputs of this work will be compiled and interrogated using machine learning techniques to provide a stakeholder user interface that can be used to detect change in GHG emissions and removals.

PI	Dr Juan Diego Rodriguez Blanco
Project Name	SEparating Critical metals ThrOugh mineRal crystallization (SEleCTOR)
Funder	Science Foundation Ireland
Value	€474,646
Length	48 months
Contract Signed	29/04/20220
Details	**Note – award made but formal announcement pending** The rare-earths are a group of 17 chemical elements that are essential for clean and smart technologies (smartphones, computers, lasers). We extract them from rocks, but in order to be useful industrially, these elements have to be separated from each other. Separation processes are inefficient and environmentally aggressive: large quantities of rare-earths are lost, as they become part of heavily contaminated wastewaters that are not recovered. SEleCTOR will develop clean and cheap methods to separate rareearths from water by designing engineered nanoparticles with targeted structural and surface properties that will control the selective capture of specific rare earths.

School of Engineering

PI	Dr Sarah Mc Cormack
Project Name	IDEAS
Funder	European Commission
Value	€4mil total, €625k TCD
Length	36 months
Contract Signed	12/03/20219
Details	Buildings play a significant role in the global energy balance. Typically, they account for 20-30% of the total primary energy requirement of industrialized countries, 40% in EU. Applying the proposed integrated RES to buildings is an important application for wider integration and deployment of renewable energy and to achieving our binding EU targets of at least a 40% reduction in greenhouse gas emissions (GHG) by 2030, compared to 1990 and at least 27% of renewable energy in EU. The IDEAS project will create an innovative building integrated renewable energy system (RES) which will cost effectively exceed current RES efficiencies, generating electricity, heat and cooling and optimised for multifamily, public and commercial buildings in different climatic conditions. The research aim is to create a novel low-cost building integrated RES maximizing the output tuneable for different climatic conditions through novel luminescent and geometric concentrator techniques leading to current solar system efficiencies being exceeded electrically. Thermally enhancement will be achieved using enhanced organic phase change materials (PCM) with a passive biomimetic heat transfer mechanism for heat storage and discharge. An electrically driven multi-source heat pumpHP system will then use the main energy sources at building scale (waste heat from the system, air and ground), to provide the input to an integrated underfloor heating and hot water system, and to manage the thermal energy storage. This building integrated RES will use advanced control techniques to maximize performance and electrical and thermal/cooling self-sufficiency in the building. The technology will be optimized and demonstrated for use in multi-family residential buildings, commercial and public buildings.

PI	Prof. Laurence Gill
Project Name	BIOMAT: The influence of the biomat on on-site wastewater contaminant transport and attenuation
Funder	Irish Research Council (Laureate)
Value	€400,000
Length	48 months
Contract Signed	08/11/2018
Details	Much of the world's domestic wastewater is discharged locally into soil where attenuation and biogeochemical cycling processes act on the pollutants. This research aims to provide a fundamental re-evaluation of the overall environmental sustainability of on-site wastewater treatment in order to enhance the attenuation of pollutants going to groundwater whilst providing new knowledge concerning the emission of greenhouse gases to the atmosphere. This ambitious work will provide new perceptions regarding the nature and development of the microbial biomat that forms at the interface

	where wastewater effluent percolates into the subsoil and how it regulates the nature of dissolved organics and underlying soil moisture conditions which form crucial roles in contaminant attenuation processes, particularly with respect to nitrogen, viruses and engineered nanoparticles. The project will be carried out by highly instrumented field studies in different soil conditions, controlled laboratory column studies as well as numerical modeling to extrapolate the research findings. For the first time, the different mechanisms of nitrogen removal in the unsaturated zone beneath such percolation areas, whether from partial or full denitrification and/or anammox, will be quantified by a combination of stable isotopic and molecular biological analyses on the percolating effluent as well as soil cores taken beneath the infiltration interface. A combination of phage and engineered nanoparticle spiking trials in the field and in controlled laboratory column studies will also be used to elucidate the impact of dissolved organics beneath the biomat on their subsequent transport and attenuation. The new insights into these organic transformations and pollutant transport processes will also be incorporated into numerical modeling approaches which can simulate transient variably-saturated flow conditions.

PI	Prof. Aonghus Mc Nabola
Project Name	REDAWN: Fostering Greater Resource Efficiency in Water Networks
Funder	European Regional Development Agency
Value	€2.9 mil total, €380,000 TCD
Length	36 months (**NB – Project may now be completed**)
Contract Signed	17/11/2017
Details	REDAWN aims to foster the adoption of hydropower energy recovery technology in built water networks in the Atlantic Area (AA). REDAWN will develop an adequate institutional, social and technological environment to foster greater resource efficiency in water networks, including: • Completion of an energy recovery resource assessment in water networks in the AA • Completion of an economic/environmental impact assessment of this technology on the region • Development of design guidelines and support tools for hydropower energy recovery in drinking water, waste water, irrigation and process industry sectors. • Development of policy and institutional support tools to increase the implementation of energy recovery projects • Quantification of the societal impacts of hydropower energy recovery in water networks • Widespread dissemination and promotion of energy efficiency in AA water networks

PI	Bidisha Ghosh
Project Name	Mitigation of Air Pollution Impacts of Irish Heavy Duty Vehicles (MAP-HDV)

Funder	Sustainable Energy Authority of Ireland
Value	€120,000
Length	24 months
Contract Signed	29/03/2018
Details	Heavy Duty Vehicles (HDV) produce significant vehicular emission which is expected to increase due to economic growth and subsequent increase in freight movement in Ireland. MAP-HDV is designed to explore and establish environmental, economic and health impact of the vehicular emission generated from the Irish HDV fleet along with developing an appropriate tool-kit to monitor and calculate future energy consumption and related vehicular emission from the fleet using most advanced simulation tools. Transport modelling and related air pollution estimation tools will be utilised in the project. Eco-driving as an option of reducing HDV emission will be explored.

PI	Dr Craig Meskell
Project Name	Closed Cycle Power Take Off for OWC Wave Energy Devices
Funder	Sustainable Energy Authority of Ireland
Value	€220,000
Length	24 months
Details	Wave power has long been an attractive potential source of renewable energy. Wave power has: the highest energy density among renewable energy sources; high availability; good predictability; and is decorrelated with wind and solar power. This is true in many locations in the world, not just Ireland, so this represents a global market for commercialization. However, wave energy is still in infancy, with a large number of concepts at various stages of development. One class of device is called the oscillating water column (OWC) in which the wave power is transferred to air flow. Two problems have dogged the development: the air flow through the turbine is bidirectional and the turbine experiences a large variation in peak pressures in irregular seas. The Closed Cycle Power Take-Off (CCPTO) is a novel concept that addresses both these problems. However, the sensitivity of the CCPTO to basic geometric sizing (e.g. volume of air accumulators) or the likely performance with realistic turbine characteristics is unknown. Furthermore, the appropriate configuration of the turbine for a CCPTO is undefined. This project will bridge this knowledge gap. This will be achieved by using turbine data obtained from high fidelity computational fluid dynamics simulations coupled conjunction with reduced order models of the device. This will also allow an exploration of possible control strategies that may enhance operation. Thus, the project will advance the CCPTO concept beyond the current low technology readiness level of 1-2 to a TRL of 3 and will provide a design framework for further development

School of Physics

PI	Professor Igor Shvets
Project Name	Increasing energy efficiency of minerals processing operations by advanced sensor-based sorting of ores (ENEROS)
Funder	Sustainable Energy Authority of Ireland

Value	€190,000
Length	18 months **NB – yet to commence**
Details	The mining industry faces the ever-growing problem of increasing mineral demand while fewer new exploitable deposits are being discovered, reserves continually deplete, and mine grades diminish. The current solution to this is to increase the amount of ore mined and processed to sustain production against the declining quality/grade of ore. The energy cost and carbon footprint of this approach is staggering. There are two main drivers leading to high the energy cost of mining. Firstly, the vast quantities of ore need to be milled into micron-size powder. This is required to liberate the minerals from the waste rock using the flotation process. Secondly, vast quantities of chemicals are required for the flotation process. ENEROS will develop and validate an ore sorting technology designed to reduce costs and energy footprints of mining operations. We address the mining industry's problem of uneconomical deposits and diminishing ore grades, and hence the EU's strategic concerns of the supply of critical materials. The proposed sorting system makes use of cutting-edge sensor designs as well as modern machine learning techniques. ENEROS will also evaluate the commercial potential of this ore sorting technology. The goal is seamless integration into primary mining chains in Europe and further afield. The ENEROS technology is potentially applicable to many raw materials that are crucial for the modern society such as copper, lithium, nickel, zinc. Many of these elements are crucial for the development of low carbon energy technologies. For example lithium is an innovation-critical material of extreme importance to battery technology.

PI	Dr David McCloskey
Project Name	SolarCool - Improving Solar Panel Performance in Arid Climate Conditions
Funder	Science Foundation Ireland
Value	€282,000
Length	12 months
Contract signed	03/12/2019
Details	Challenge Developments in the solar power industry over the past 50 years have led to improvements in both efficiency and economic viability of solar power installations; for example, the cost has dropped from an average of 76.67 USD/Watt in 1977 to 0.37 USD/Watt in 2017. Large-scale solar PV is now becoming competitive with other renewable technologies such as offshore wind. This project aims to address the major issues associated with the operation of solar cells in high ambient temperature arid environments for prolonged periods of time. These areas have particularly high resources of solar energy up to 2500 kWhr/m2/ year, which over twice that of Northern Europe or Ireland. Ambient temperature in these climates can reach above 50oC during the day and -20oC at night, and the solar Panels themselves can easily reach temperatures over 100oC. We are working together with Concern Worldwide to ensure that this technology can have societal impact in developing economies in Africa, where over 64% of the continent can be classified as arid or semi-arid.

	Solution In this project we will take a novel approach of addressing overheating issues in solar photovoltaics at both the solar cell and solar panel level. Silicon based solar cells are currently designed to operate optimally at 25oC typical in European climates, and in arid desert environments efficiency can be up to 30% lower than rated values. What's more, average module operational lifetime is significantly reduced. This project will develop technology to reduce operating temperature of solar panels in this environment and thus further lower cost by increasing efficiency and operational lifetime to enable large-scale uptake of the technology.

Faculty of Arts, Humanities and Social Studies

PI	Prof. Poul Holm
Project Name	Foodsmart Dublin
Funder	Irish Research Council
Value	€220,000
Length	24 months
Contract Signed	13/02/2019
Details	We argue that a change in human consumption towards eating seafood at lower trophic levels may be encouraged by discovering forgotten cultural practices and tapping into locally-sourced marine resources. By identifying historical recipes of seafood from Dublin Bay that can be innovated and used in appetizing dishes we aim to stimulate sustainable food practices amongst Dublin's society and respond to the Report on Food from the Oceans (2017). We are working with second-level students and local restaurateurs to identify and create delicious recipes, while contributing to Dublin's growing image as a Smart City.

PI	Ruth Brennan (supervisor Poul Holm)
Project Name	Co-Sustain: Collaborative Sustainable Innovation co-designing small-scale fisheries governance approaches
Funder	European Commission Marie Sklodowska Curie Actions
Value	€176,000
Length	24 months
Contract Signed	29/03/2018
Details	CO-SUSTAIN is an interdisciplinary research project hosted by the Trinity Centre for Environmental Humanities and led by Dr Ruth Brennan under the sponsorship of Prof. Poul Holm. From October 2018 to October 2020, Dr Brennan will work closely with the Irish Islands Marine Resources Organisation (IIMRO) to co-design and test innovative governance approaches that promote good governance, foster marine stewardship and contribute to sustainability goals while meeting the need of fisheries-dependent coastal communities to flourish

PI	Eleanor Denny
Project Name	CONSEED: CONsumer Energy Efficiency Decision Making
Funder	European Commission
Value	Total €1.5mil; TCD €482,000

Length	36 months
Contract Signed	29/07/2016
Details	Do European consumers pay attention to energy labels when they buy an electric appliance, a car or a house? What information are they looking for? How important is energy consumption in their decisions? The CONSEED is a Horizon 2020-funded project that ran between 2016 and 2019, which found answers to these questions through surveys and field trials among households and various economic sectors across Europe.

AMBER

PI	Ramesh Babu (TCD lead – lead partner Athlone Institute of Technology)
Project Name	Biocept: *Bioconstruction of a Circular Economy for PlasTics*
Funder	European Commission
Value	€5mil across all partners
Length	48 months
Contract Signed	29/10/2019
Details	Europe's waste management policy has evolved over the last 30 years – shifting away from discarding waste as an unwanted burden to seeing it as a valued resource. Today, plastic waste is considered a priority waste stream. The EU-funded BioICEP project aims to reduce the burden of plastic waste. Forming a European-Chinese collaboration, the project will develop a solution for mixed plastic pollution environments. Specifically, researchers will work on three innovative booster technologies aimed at increasing plastics degradation to record levels. BioICEP will take a triple-action depolymerisation systems approach to break down plastic waste: mechano-biochemical disintegration processes, biocatalytic digestion and microbial consortia. The outputs will be used as building blocks for new polymers or other bioproducts.

PI	Ramesh Babu (TCD lead – lead partner Glanbia)
Project Name	: AgriChemWhey - An Integrated Biorefinery For the Conversion of Dairy Side Streams to High Value Bio-Based Chemicals
Funder	European Commission: BioBased Industries Flagship project
Value	€22mil across all partners
Length	48 months
Contract Signed	09/05/2017
Details	*Seeks to build a first-of-a kind, industrial-scale bio-refinery which will take by-products from the dairy processing industry and convert them into cost competitive, sustainable lactic acid*. https://www.agrichemwhey.com/

PI	Prof. Valeria Nicolosi
Project Name	3D2D Print - 3D Printing of Novel 2D Nanomaterials: Adding Advanced 2D Functionalities to Revolutionary Tailored 3D Manufacturing
Funder	European Research Council
Value	€2.5mil
Length	60 months
Contract signed	26/07/2016

Details	Batteries and supercapacitors are two very complementary types of energy storage devices. Batteries store much higher energy densities; supercapacitors, on the other hand, hold one tenth of the electricity per unit of volume or weight as compared to batteries but can achieve much higher power densities. Technology is currently striving to improve the power density of batteries and the energy density of supercapacitors. To do so it is imperative to develop new materials, chemistries and manufacturing strategies. 3D2DPrint aims to develop micro-energy devices (both supercapacitors and batteries), technologies particularly relevant in the context of the emergent industry of micro-electro-mechanical systems and constantly downsized electronics. We plan to use novel two-dimensional (2D) nanomaterials obtained by liquid-phase exfoliation. This method offers a new, economic and easy way to prepare ink of a variety of 2D systems, allowing to produce wide device performance window through elegant and simple constituent control at the point of fabrication. 3D2DPrint will use our expertise and know-how to allow development of advanced AM methods to integrate dissimilar nanomaterial blends and/or "hybrids" into fully embedded 3D printed energy storage devices, with the ultimate objective to realise a range of products that contain the above described nanomaterials subcomponent devices, electrical connections and traditional micro-fabricated subcomponents (if needed) ideally using a single tool.

PI	Prof. Wolfgang Schmidt
Project Name	Towards Artificial Enzymes: Bio-inspired Oxidations in Photoactive Metal-Organic Frameworks
Funder	European Research Council
Value	€2mil
Length	60 months
Contract signed	21/08/2015
Details	Metal-organic frameworks (MOFs) are key compounds related to energy storage and conversion, as their unprecedented surface areas make them promising materials for gas storage and catalysis purposes. We believe that their modular construction principles allow the replication of key features of natural enzymes thus demonstrating how cavity size, shape, charge and functional group availability influence the performances in catalytic reactions. This proposal addresses the question of how such novel, bio-inspired metallo-supramolecular systems can be prepared and exploited for sustainable energy applications. A scientific breakthrough that demonstrates the efficient conversion of light into chemical energy would be one of the greatest scientific achievements with unprecedented impact to future generations.