UNNC – SDU (SEPE) Doctoral Training Partnership

It's essential that you have contacted the UNNC and/or SDU supervisors before applying.

Formal applications should follow the instructions in 'How to apply' section.

Research areas

1. *Green energy and low/zero carbon engineering & science*
2. *Recycling of solid wastes as green materials and value-added products*

Available PhD topics

PhD topic	**Advanced Study on Thermal Management for Lithium-ion Battery Energy Storage System: From Materials Discovery to System Design**
SDU Supervisor	Prof. Jia-Yue Yang
UNNC Supervisor(s)	Dr Yong Shi
Short introduction & description of the PhD project	The last decade has witnessed rapid development of renewable energy technologies, and triggered a surge of interest in the relevant energy storage (ES) systems. Currently, most of those ES systems use lithium-ion batteries, whose performance, security, and life cycle are significantly affected by the battery thermal states. Therefore, it is essential for lithium-ion batteries in practical use to be equipped with a battery thermal management (BTM) system. In this project, we will focus on thermal characteristics of lithium-ion batteries in different operating scenarios. From materials perspective, this project first utilizes multiscale simulations including first-principles, molecular dynamics and finite elements to understand heat transport in core materials of battery and help discover candidates with excellent thermal performance. This study is then extended to BTM system design. To efficiently respond to various cooling, warming and even heating needs, such designs will integrate multiple thermal-management means, and will be optimized by both CFD modelling and machine-learning techniques. Its effectiveness will be also examined through experiments in different battery operating modes and under different thermal conditions.
Contact points	Informal inquiries may be addressed to Dr. Yong Shi (Yong.Shi@nottingham.edu.cn) and Prof. Jia-Yue Yang (jy_yang@sdu.edu.cn).

PhD topic	**Assessment and optimization of low-carbon buildings in Chinese cities based on multi-objective synergy of energy, environment and costs**
SDU Supervisor	Prof. Qingsong WANG
UNNC Supervisor(s)	Dr Wu DENG
Short introduction & description of the PhD project	As urbanization is accelerating, it is obvious that the energy consumption and carbon emissions caused by urban buildings in China, as well as their impact on the economy, are becoming more and more significant, which is the reason that China has listed building energy efficiency as one of the most important ways to achieve the carbon peak. Thus, it is particularly important to establish a low-carbon building assessment system that takes into account the multiple objectives of reducing energy consumption, carbon emissions, and costs. At present, the research methodology consists of the possibility of improving the low-carbon built environment by technically optimizing the building layout, integrating renewable energy technologies such as solar, wind, and geothermal energy, and systematically assessing the use of life-cycle assessment, indicator system establishment, and 3E (energy, environmental and economic) assessment methods. The project will focus on three main aspects: (i) Multi-objective optimal design of low carbon buildings. (ii) Assessment of synergistic and complementary assessment of different energy sources in buildings. (iii) Carbon transfer in low carbon buildings.
Contact points	Informal inquiries may be addressed to Dr Wu DENG (wu.deng@nottingham.edu.cn) and Prof. Qingsong WANG (wqs@sdu.edu.cn).
PhD topic	**Catalytic Materials Design for Sustainable Environmental and Energy Solutions: Integrating Experiment and Computation**
SDU Supervisor	Dong Wang
UNNC Supervisor(s)	Muhammad Sajjad
Short introduction & description of the PhD project	This PhD research project integrates experimental and computational methods (based on density functional theory (DFT) simulations) to explore catalytic processes for environmental and energy applications. The experimental side involves synthesizing and characterizing catalyst materials, studying reaction kinetics, and employing various analytical techniques. On the computational front, DFT simulations will be incorporated to establish atomic-level understanding. The project's applications include environmental catalysis for pollution reduction and energy catalysis for sustainable energy production. The goal is to design more efficient and sustainable catalysts by combining experimental observations with theoretical insights.
Contact points	Informal inquiries may be addressed to Dong Wang (dwang@sdu.edu.cn) and Muhammad Sajjad (muhammad.sajjad@nottingham.edu.cn).

PhD topic	**Converting gold tailings into value-added road materials and prefabricated components**
SDU Supervisor	Prof. Wenlong Wang
UNNC Supervisor(s)	Dr Bo Li
Short introduction & description of the PhD project	The current storage of gold tailings poses serious environmental pollution and safety hazards, which is a major issue that urgently needs to be addressed in the construction of ecological civilization. There are various forms of utilization of gold tailings. Firstly, the main minerals contained in gold tailings can be used as raw materials to prepare high-performance and low-carbon cementitious materials (LCM). The LCM prepared by calcination of gold tailings with other solid wastes has the characteristics of early and high strength which can be targeted as an alternative to rapid-setting cement. Secondly, gold tailings can be used to prepare the cold-bonded lightweight aggregates (LWAs). Adding cementitious materials during the preparation process of LWAs can produce non-steaming LWA products, which are widely used in the production of road prefabricated components such as curbstones and isolation belts. This project will focus on the following major dimensions. (i) Breaking through the limitations of mineral systems and ranges of ordinary Portland cement clinker; Improving the utilization rate of gold tailings in road engineering materials; Optimizing the performance of road materials, and reducing their production cost. (ii) Using LWAs to prepare lightweight and high-strength prefabricated components such as curbstones, which can be widely used in road construction and achieve the concept of green, energy-saving, and environmental protection. (iii) Study on the durability of prefabricated components.
Contact points	Informal inquiries may be addressed to Prof Wenlong Wang (wwenlong@sdu.edu.cn) and Dr Bo Li (Bo.Li@nottingham.edu.cn).
PhD topic	**Design and Optimization of Thermal Management Systems**
SDU Supervisor	Prof. Gongming XIN
UNNC Supervisor(s)	Dr. Yong SHI
Short introduction & description of the PhD project	Thermal management plays an essential role for many modern devices and systems, including but not limited to electronic devices, battery packs, data centers, energy thermal management systems and *et al*. Without proper thermal management these devices can overheat, leading to reduced performance, shortened lifespan, and potential damage to components. Therefore, it is indispensable to equip them with thermal management to uphold their efficiency, safety, and robust functionality. Today, the design and optimization of thermal management systems have been one of linchpins requiring in-depth studies to cope with rapid development of various modern manufacturing processes and energy systems. This project focuses on the innovative development of advanced thermal management systems. By taking advantage of the expertise of the supervisor teams from both Shandong University and University of

	Nottingham Ningbo China, we provide a variety of topics for students to choose, including development of cooling systems of electronics devices, design of liquid-cooling components for data center, thermal control of battery systems, and energy saving in industrial processes. Interested students are encouraged to contact the supervisors for more details.
Contact points	Informal inquiries may be addressed to Dr. Yong SHI (Yong.Shi@nottingham.edu.cn) and Prof. Gongming XIN (xingm@sdu.edu.cn).
PhD topic	**Development of AI-enabled Optimization Methodology and Tool for achieving carbon neutrality of district's Urban Morphologies in Chinese Cities**
SDU Supervisor	Prof. Yuzhong Li
UNNC Supervisor(s)	Dr. Rabee Reffat
Short introduction & description of the PhD project	In China's route to carbon neutrality there is still significant potential for efficiency improvements of energy consumption in buildings and urban infrastructure. The rapid urbanization and increasing energy demand in cities pose significant challenges for achieving carbon neutrality. Accordingly, there is a need to develop innovative methodologies and models that can effectively address these challenges. These methodologies include enabling the optimization of urban morphologies, considering factors such as building design, energy systems, transportation networks, and land use patterns. This project focuses on harnessing the power of artificial intelligence (AI) to optimize energy-efficient urban morphologies. This requires employing a multidisciplinary approach to tackle the complex interactions between urban morphology, energy consumption, and environmental impacts. This project will focus on utilizing advanced AI techniques, including machine learning, multi-objective integrated evaluation and optimization, parametric modelling using BIM technology, green building energy-saving technology and data analytics, to analyse large-scale urban data, simulate scenarios, and to identify optimal urban configurations that minimize energy consumption and environmental footprints. Existing urban planning strategies, energy systems, and decision-making frameworks in China will be examined to identify gaps and opportunities for improvement. Data on energy consumption, urban morphological factors, and environmental parameters will be collected and analysed especially in newly established districts in Chinese cities. This data-driven approach will provide valuable insights into the current energy profiles and urban characteristics, enabling the development of context-specific solutions. The expected outcomes of this project include developing methodologies and computational intelligent tools that will facilitate evidence-based decision-making and support policymakers in developing sustainable and carbon-neutral urban morphologies in Chinese cities.

Contact points	Informal inquiries may be addressed to Associate Prof. Rabee Reffat (rabee.reffat@Nottingham.edu.cn) and Prof. Yuzhong Li (lyz@sdu.edu.cn).
PhD topic	**Development of High-Performance Copper-Nitrogen-Doped Carbon Catalysts for ECO_2R-to-Ethanol in a Flow Cell**
SDU Supervisor	Dr. Xiaoxu Xuan
UNNC Supervisor(s)	Dr. Mengxia Xu
Short introduction & description of the PhD project	The pressing need of mitigation of CO_2 emissions and growing demand of carbon feedstocks enable the electrocatalytic CO_2 reduction (ECO_2R) as one of the most attractive clean energy technologies towards carbon neutrality. Among various ECO_2R products, ethanol is one of the most important chemical feedstocks. Nevertheless, the performance of ECO_2R-to-ethanol is still far from commercial requirements. Copper has earned its distinction as the only catalyst capable of converting CO_2 into multicarbon products (e.g., ethanol) with high efficiency and selectivity. The copper-based electrocatalysts can be broadly divided into three main groups: oxide-derived copper, bimetallics, and copper-nitrogen-doped carbon materials (NC-Cu), where NC-Cu holds the largest potential for enhanced selectivity towards ethanol. A flow cell is a type of electrolytic cell consists of gas diffusion electrodes (GDEs) that can greatly enhance the activity of ECO_2R compared to H-cell but requires catalysts to possess high electrical conductivity and gas permeability. Carbon materials in NC-Cu can improve the conductivity of metal catalysts and provide large specific surface area, which are conducive to the loading of metal atoms. Besides, the addition of N atoms can alter the structural properties of carbon materials and modulate the synergistic effects of metals and heteroatoms leading to improved efficiency of ECO_2R-to-ethanol. Thus, the aim of this research project is to develop NC-Cu catalysts for ECO_2R-to-ethanol in a flow cell with enhanced activity and elucidate the reaction mechanisms involved.
Contact points	Informal inquiries may be addressed to Dr Mengxia Xu (Mengxia.Xu@nottingham.edu.cn) and Dr Xiaoxu Xuan (xiaoxuxuan@sdu.edu.cn).
PhD topic	**Experimental and DFT study for Environmental and Energy Application**
SDU Supervisor	Dong Wang
UNNC Supervisor(s)	Muhammad Sajjad
Short introduction & description of the PhD project	This PhD research project integrates experimental and computational methods (based on density functional theory (DFT) simulations) to explore catalytic processes for environmental and energy applications. The experimental side involves synthesizing and characterizing catalyst materials, studying reaction kinetics, and employing various analytical techniques. On the computational front, DFT simulations will be incorporated to establish atomic-level understanding. The project's applications include environmental catalysis for pollution reduction and energy catalysis for sustainable energy production. The goal is to design

	more efficient and sustainable catalysts by combining experimental observations with theoretical insights.
Contact points	Informal inquiries may be addressed to Dong Wang (dwang@sdu.edu.cn) and Muhammad Sajjad (muhammad.sajjad@nottingham.edu.cn).
PhD topic	**Microchannel mass transfer, focusing on gas-liquid mass transfer mechanism and efficient mass transfer methods for miniaturized equipment**
SDU Supervisor	Prof.Dr. Jingzhi Zhang
UNNC Supervisor(s)	Prof.Dr. Yong Ren
Short introduction & description of the PhD project	Since the proposal of the micro -electromechanical system, natural science and engineering technology have begun to develop towards miniaturization, and the field of micro -current control has become a hotspot. Micro -flow control systems are widely used in multi -phase stream fields due to the advantages of miniaturization, high heat transfer performance, strengthening hybridness, rapid response, higher stability and easy replication. Studying the two -phase flow and mass transmission process in the microcontroller can provide guidance for the design and improvement of quality efficiency of micro -channel reactors.
Contact points	Informal inquiries may be addressed to Prof.Dr. Yong Ren (Yong.ren@nottingham.edu.cn) and Prof.Dr. Jingzhi Zhang (zhangjz@sdu.edu.cn).
PhD topic	**Microwave-enhanced/driven catalytic pyrolysis of methane to produce CO_2-free hydrogen (Turquoise H_2)**
SDU Supervisor	Dr Jing Sun
UNNC Supervisor(s)	Dr Nicholas Musyoka Dr Paulo Debiagi
Short introduction & description of the PhD project	Previous high-level techno-economic studies have reported that the feasibility of turquoise hydrogen production from sustainably obtained methane (or bio-methane) is heavily dependent on the price of the hydrogen and carbon product streams. Therefore, the main aim of the proposed study is to develop a process for producing turquoise hydrogen production process more feasible and economically competitive. Methane catalytic pyrolysis is a promising strategy that can be employed to produce hydrogen and valuable carbons, with no CO_2 emissions. When coupled with a microwave-enhanced approach, in a hybrid fixed bed reactor, the pyrolysis process can be promoted to result in faster reaction rates and controllable carbon quality. Furthermore, pristine and modified catalytic and sorbent materials will be utilised. The experimental activity will be conducted in parallel with modelling and simulation activities, using methods of detailed chemical kinetics. These activities are complementary in unravelling details of the process that cannot be easily measured or predicted. Ultimately, the project aims to advance towards the fabrication of a demonstratable/customizable modular unit tailored for the pyrolysis

	reaction for the continuous production of hydrogen from renewable biomethane feedstock.
Contact points	Informal inquiries may be addressed to Dr Jing Sun (sunj7@sdu.edu.cn) Dr Nicholas Musyoka (Nicholas.Musyoka@nottingham.edu.cn) Dr Paulo Debiagi (Paulo.Debiagi@nottingham.edu.cn)
PhD topic	**Process optimisation for liquid organic hydrogen carriers (LOHC) technology**
SDU Supervisor	Ming Gao
UNNC Supervisor(s)	Xiaolei Fan Xiaoxia Ou
Short introduction & description of the PhD project	Hydrogen storage and transportation is the key technology for the large-scale application of hydrogen energy. Liquid organic hydrogen carriers (LOHC) technology is low cost with high hydrogen storage density, high safety and stability. LOHC can cope with the existing fossil energy transportation facilities and is expected to be used in large-scale, long-distance and distributed hydrogen storage and transportation scenarios. However, the low efficiency and poor stability of the LOHC dehydrogenation process may restrict the development of this technology. The project aims to improve the LOHC technology in terms of dehydrogenation catalysts design, mass transfer efficiency and energy efficiency enhancement, which can contribute to the practical application of LOHC hydrogen storage technology.
Contact points	Informal inquiries may be addressed to gm@sdu.edu.cn and xiaoxia.ou@nottingham.edu.cn.
PhD topic	**Recycling of lithium-ion batteries to produce MOFs for gas storage and separation applications**
SDU Supervisor	Dr Jing Sun
UNNC Supervisor(s)	Dr Nicholas Musyoka Dr Paulo Debiagi
Short introduction & description of the PhD project	Despite the tremendous interest in metal-organic frameworks (MOFs), the key bottleneck towards their commercialisation is their high cost of production. The strategy of utilisation of unconventional starting feedstocks is proposed as one of the key approaches for lowering the cost of production. Previous studies have demonstrated that organic linkers that are derived from waste polyethylene terephthalate (PET) plastic bottles can be successfully utilised. On the other hand, few studies have also demonstrated the use of metals obtained from wastes such as Mn obtained from coal combustion by-products (fly ash) and LiMnO batteries and the resulting MOFs were used in the fabrication of asymmetric supercapacitors. With the appreciation that gas storage and separation is currently a hot topic that will play a key role in supporting the actualisation

	of the Carbon Capture and Utilisation (CCU) endeavours, the production of low-cost, high-performance and high surface area sorbent materials is of great interest. Therefore, the proposed study will utilise the six types of spent lithium-ion batteries (Lithium cobalt oxide (LCO), Lithium Manganese Oxide (LMO), Lithium nickel manganese cobalt oxide (NMC), Lithium nickel cobalt aluminum oxide (NCA), and Lithium titanate (LTO)) to harvest the metal species that will be used as feedstock for producing different metal-centred MOFs. A holistic strategy of combining organic linkers from waste will also be tested. These MOFs will be thoroughly characterised, and their performance in gas separation and storage will be compared with the MOFs obtained from conventional/commercial sources of metal salts.
Contact points	Informal inquiries may be addressed to Dr Jing Sun (sunj7@sdu.edu.cn) Dr Nicholas Musyoka (Nicholas.Musyoka@nottingham.edu.cn) Dr Paulo Debiagi (Paulo.Debiagi@nottingham.edu.cn)
PhD topic	**Research on Carbon Emissions Inventory from New Energy Vehicles through Road Traffic Measurements**
PhD topic	Prof. Wenbin Yu
SDU Supervisor	Prof. Jun He
UNNC Supervisor(s)	Road traffic is one of the main sources of carbon emissions that cause climate change. Despite numerous studies on road traffic emissions, significant challenges remain in carbon emissions measurement and quantitative evaluation of mitigation effects. Currently, as an important vehicle activity recognition method, vehicle specific power (VSP) has been widely used for on-road traffic CO2 emission modelling. The conventional VSP is calculated from externally observable variables on the vehicle level and is mainly used for vehicles equipped with internal combustion engines with fossil fuel. However, more effective and reliable accounting methods for carbon emissions are still lacking for new energy vehicles. This project will focus on the development of carbon emission inventory model for hybrid vehicles and battery electrical vehicles.
Contact points	Informal inquiries may be addressed to Prof. Wenbin Yu (wbyu@sdu.edu.cn) and Prof. Jun He (jun.he@nottingham.edu.cn).
PhD topic	**Study on hydration and mineralization mechanisms of municipal solid waste incineration fly ash (MSWI-FA) based cementitious materials**
PhD topic	Dr. Xujiang Wang
SDU Supervisor	Dr. Mengxia Xu
UNNC Supervisor(s)	Municipal solid waste incineration (MSWI) has gained increasing attention as a waste reduction and resource utilization method to dispose municipal solid waste (MSW). However, during the incineration process, MSW

	incineration fly ash (MSWI-FA) is generated as a hazardous by-product, constituting ca. 20% of the original mass of MSW. On the other hand, MSWI-FA has high contents of calcium oxide and silicon dioxide, which are the two main chemical components of cementitious material. Cement is widely used in the construction industry but its production is energy-intensive and accounts for approximately 8% of global CO_2 emissions. Therefore, the conversion of MSWI-FA to raw material or supplementary cementitious materials (SCMs) can not only achieve the harmless treatment and resource utilization of MSWI-FA, but also reduce the use of cement, thus indirectly contribute to the goal of carbon neutrality. Compared with OPC, SCMs may contain higher amounts of Al_2O_3, which reduces the CaO content in the composites, which affects the average Ca/Si ratio in hydration products and microstructure development. Hence, it is necessary to adjust the compositions of Si, Al, Ca, and other chemicals in multiple solid wastes while preparing SCMs. Additionally, carbonization of concrete is a potential way to capture CO_2. However, after CO_2 mineralization, harmful elements such as heavy metals contained in MSWI-FA based cementitious materials may be at risk of leaching, but the effect is still unknown. Therefore, the objectives of this project are to study the hydration and mineralization of MSWI-FA based SCM, and investigate the leaching behaviours after CO_2 mineralization.
Contact points	Informal inquiries may be addressed to Dr Mengxia Xu (Mengxia.Xu@nottingham.edu.cn) and Dr Xujiang Wang (xiaoxuxuan@sdu.edu.cn).
PhD topic	**Study on key technologies for hybrid powertrain of proton exchange membrane fuel cells**
PhD topic	Prof.wei yan
SDU Supervisor	Prof.yong ren
UNNC Supervisor(s)	Energy and environmental issues have been major problems faced by countries around the world in recent decades. The technical research and utilization of new energy sources such as hydrogen energy have become important directions of global research. Fuel cells, as a representative of hydrogen energy utilization technology, have broad application prospects. Due to a series of advantages such as high efficiency, zero emissions, and no noise, they can be applied to multiple fields such as automobiles and distributed power generation, etc. In the project, we mainly focus on developing the performance optimization of proton exchange membrane fuel cells. The main tasks include 1.the optimization of fuel cell structure parameters based on multi-scale simulation; 2. the simulation and control of fuel cell low-temperature start-up performance； 3. fuel cell water-heat management; and 4. the matching of fuel cells and power batteries hybrid power assembly.
Contact points	Informal inquiries may be addressed to Prof. wei yan (yanwei@sdu.edu.cn) and Prof. yong ren (Yong.ren@nottingham.edu.cn).

PhD topic	**Study on Phase Change Material-based Thermal Management System for Lithium Power Batteries in Electric Vehicles**
PhD topic	Prof.Wei Yan
SDU Supervisor	Dr.Yong Shi
UNNC Supervisor(s)	The increasingly worldwide environmental pollution and energy crisis have promoted large scale rapid transition in the current automobile sector from traditional internal combustion engine vehicles to new energy vehicles. Among various new energy vehicles, electric vehicles using lithium-ion battery have received widespread attention from researchers and manufacturers due to their many distinct advantages. However, lithium-ion battery, as a complex electrochemical system, involve many physical and chemical processes. For example, its heat and mass transfer always couple with various electrochemical reaction kinetics. Moreover, with its increasing energy density and expansion of its application scenarios, lithium-ion battery also suffers from rapid growth of its temperature and large temperature gradients, which will lead to significant performance degradation and safety risks. In light of these issues, it is particularly crucial to develop and design effective thermal management systems to regulate the battery thermal states. In this project, we will focus on developing thermal management system for lithium-ion power battery. The main tasks include 1. power battery parameter identification based on intelligent theory; 2. multi-scale modeling and experimental study on phase change material-based thermal management system; 3. Simulation and control of battery thermal runaway and 4. environmental adaptability of phase-change-material-based thermal management design based on vehicle integration.
Contact points	Informal inquiries may be addressed to Prof. Wei Yan (yanwei@sdu.edu.cn) and Dr. Yong Shi (yong.shi@nottingham.edu.cn).
PhD topic	**Sustainable Catalysis Application of Solid Waste**
PhD topic	Dong Wang
SDU Supervisor	Tao Wu
UNNC Supervisor(s)	This PhD research project focuses on sustainable catalysis, specifically exploring the application of solid waste as a resource. By repurposing waste materials into catalysts, the research aims to contribute to environmental sustainability and resource efficiency. Through experimental and theoretical methods, the project transforms solid waste into functional catalysts for applications in environmental remediation and industrial processes, aligning with principles of circular economy and waste-to-value. The significance lies in developing environmentally friendly and resource-efficient catalytic systems while addressing challenges in solid waste management.
Contact points	Informal inquiries may be addressed to Dong Wang (dwang@sdu.edu.cn) and Tao Wu (tao.wu@nottingham.edu.cn).