**NOMINATIONS FOR THE FUELLERS CHARLES STEPHENSON CLARKE AWARDS 2024**

The following candidates were nominated by the Programme Director at City University based on both academic achievement and their attitude to study.

**1st Prize - LEANDRO ITTURALDE RODRIGUEZ – Green Hydrogen Production**

This study aims to evaluate the potential of green hydrogen production in Uruguay by using grid-connected hybrid renewable energy systems by the year 2030. While several studies have addressed the economic feasibility of hydrogen production using renewable energies for different parts of the world, very few consider the production of hydrogen based on HRES with grid assistance, as grid-connected production of hydrogen has some associated technical challenges such as guaranteeing a low grid emission factor or grid congestion issues.

Nevertheless, Uruguay’s transmission infrastructure and high penetration of renewable energies in the electricity mix can help overcome some of these challenges and give it a competitive advantage over other potential hydrogen exporters. In this work, the configuration of RES installed capacity that minimises the hydrogen production costs was determined through an optimisation model for the region of Salto, Uruguay.

A sensitivity analysis was performed to determine the impact of variations in each of the energy costs in the obtained LCOH values for Uruguay. Finally, a comparison of the LCOH results was made against those of other studies carried out for Uruguay, as well as those obtained for other potential hydrogen exporter countries. Under Uruguay’s current regulations, grid-connected green hydrogen production can reach costs of 3.07 $2023/kgH2. Furthermore, it was observed that under a modified grid cost structure, production costs can fall to 2.29 $2023/kgH2 and become competitive with off-grid production in Uruguay.

*\*\*\* Upon first review it appeared that Leandro’s thesis did not qualify as it concentrates on Uruguay rather than the UK based projects we stipulate. However, given the subject matter he was given the opportunity to clarify whether export potential had been considered. Leandro responded “While my project focused on hydrogen production in my home country (Uruguay), the purpose behind said production is the exporting of green hydrogen to those countries identified as potential hydrogen importers in Uruguay's Green Hydrogen Roadmap. The UK is one of those as can be seen in subsection 9.4 of the roadmap (please see attachment).*

*Uruguay is looking into large-scale hydrogen production with the main objective of exporting it, due to us being a small country with a population of less than 3.5 Million.*

*Furthermore, Uruguay and the UK have already had meetings regarding the prospects of green hydrogen exports and bilateral cooperation. This could help the UK meet their own decarbonisation goals while representing a great economic opportunity for Uruguay.*

*"Join Statement on the first meeting of the UK and Uruguay trade dialogue" -* [*https://www.gov.uk/government/news/joint-statement-on-the-first-meeting-of-the-uk-uruguay-trade-dialogue*](https://www.gov.uk/government/news/joint-statement-on-the-first-meeting-of-the-uk-uruguay-trade-dialogue)*”*

*After discussion, the Trust concluded this brought him back into consideration for the prize.*

**= 2nd Prize CYRUS MOTASHAW – development of electricity trading markets at distribution level**

The transition to a more sustainable and low-carbon energy system requires the development of efficient and sustainable electricity trading markets. While significant attention has been given to wholesale markets at the transmission level, the market structures at the distribution network level in the United Kingdom need to evolve to keep pace with the changing energy landscape. This thesis aims to evaluate possible market structures for developing electricity trading markets at the distribution network level in the United Kingdom, evaluate their impact at the distribution level, and evaluate and suggest relevant regulation to make them possible.

Through a comprehensive analysis of existing literature and a regulatory assessment, this research seeks to identify innovative approaches that enhance grid flexibility, enable distributed energy resource integration, and help reduce re-dispatching and congestion costs in the system as a whole.

The findings from this study will contribute to literature of the development of market structures that facilitate efficient and sustainable electricity trading at the distribution network level, supporting the transition towards a more resilient, flexible, and decarbonized energy system in the United Kingdom.

**= 2nd Prize - KYLE RARICK – leveraging Spark Gap to improve the economic viability of heat pumps**

As the UK continues down its path to achieving net zero carbon emissions by 2050, the decarbonization of the domestic heating sector has emerged as a massive technical and economic challenge. At the heart of the challenge though lies a solution. Heat pumps have proven their technical capability to provide decarbonized heat, yet their uptake remains low. This is because high capital costs and broader technical and economic implications have hindered their performance in the marketplace against boilers. Innovative policy designs in the form of the RHI and BUS schemes have been ineffective in garnering large-scale uptake despite offering financial support to prospective heat pump consumers. This has led researchers to investigate ways to bolster the proliferation of heat pumps in UK dwellings.

Researchers have carried out studies ranging from the improvement of heat pump economics via retrofit  [101] to research regarding the optimization of thermal store systems in conjunction with heat pumps [121]. While these projects are academically enriching, they are often not practical solutions for a host of consumers. As the grid is increasingly decarbonized, the cost of electricity is becoming decoupled from the cost of gas. Furthermore, the integration of a vast number of renewables has raised the demand for flexibility. The economics of heat pumps benefit from both. This is why, in this research study, a look at the developing energy market through the lens of the spark gap is explored.

With the economic viability of heat pumps fluctuating alongside the price gap between the unit price of gas and the unit price of electricity, it is important to understand how this gap can be leveraged to improve the economic viability of heat pumps. While this study found that the spark gap may not be an efficient tool for calculating the economics of heat pumps in general, it can be used in conjunction with heat pump installations to promote informed economic decisions while participating in energy markets via flexibility administration. The spark gap presents a simple metric, which can be realistically assessed by heat pump operators, and thus it presents an important topic for further academic study.

**Other submissions:**

**Distributed renewable energy resources & microgrids ……**

are emerging as prominent sources of electricity generation due to their resilience and flexibility as decentralised sources of low-carbon power.

These technologies encompass the utilisation of wind and solar resources, combined with the integration of energy storage solutions, facilitating a continuous and uninterrupted electricity supply. Meanwhile, the built environment, comprising residential, industrial, and commercial buildings, as well as roads and other infrastructural elements, has undergone rapid expansion in recent decades, primarily attributed to population growth and economic development.

This expansion, coupled with the anticipated acceleration in the electrification of transportation and heating networks is poised to substantially increase the energy demand in many developing cities, necessitating substantial improvements to their energy infrastructure. The identification of suitable sites for the implementation of these upgrades presents a challenge for governing bodies not only in the United Kingdom, but across the globe, due to limitations in available space, or the lack of technological and financial resources.

This is where satellite data and remote sensing can play a crucial role, serving as an extremely versatile source of information. In this study, satellite information was used to visualise the expansion of towns across the UK, and the obtained results were corroborated with government data.

This validation process is crucial in upholding the accuracy of satellite-derived information and can help authorities make informed decisions regarding the installation of decentralised renewable energy infrastructure, especially in regions where data accessibility is limited. This approach can greatly help countries tackle the ongoing energy trilemma, characterised by challenges in energy security, affordability, and sustainability.

**Greenhouse gas emissions from anthropogenic activities result in climate change which has catastrophic effects ranging from an increase in temperature to changes in disease patterns**. Worldwide, healthcare sector contributes to 4.6% of net carbon emissions with NHS-UK accounting for 4% of the national emissions, due to energy intensive nature and 24/7 operations. However, in 2020 NHS set target to net zero carbon footprint by 2040 which includes direct emissions, and net zero carbon footprint plus by 2045 which includes supply chain emissions.

To meet the target NHS is struggling and launched various NHS greener campaigns, on the other hand, NHS is facing various challenges in meeting the target like heavy reliance on technology upgradation for energy efficiency. Therefore, the present study deals with review of energy efficiency interventions through technological options, behavior change, and circular economy to assess their potential in reducing carbon emissions and meeting the NHS net zero carbon target by 2040 and net zero carbon plus target by 2045.

For this study, 1) a systematic assessment of studies was done and it included both qualitative and quantitative studies with a timeframe of 2015-2023 and screening was done by using Rayyan software, and 2) NHS green plans as case studies were also appraised. Furthermore, the data collected was analyzed and the results of the study revealed that all three included interventions technology, behavior change, and circular economy are effective in reducing carbon emissions and an integrated approach is key to being on track to net zero. Moreover, NHS greener plans have few gaps: inconsistent carbon reporting mechanism, the proportion of technological interventions for carbon reduction is high, economical behavior change and circular economy approaches in the plans are underrated.

Based on the findings and the literature various recommendations were proposed for NHS administration and energy managers to develop a model to decarbonize the healthcare sector by including all types of emissions, which will also serve as a role model for other types of buildings.

**As the world moves towards decarbonisation, electrification and reducing the adverse effects of global warming, the impact of the built environment becomes crucial…**

The energy sector has continued to be a significant contributor when considering global warming, with all aspects of energy generation, transportation, and consumption responsible for emitting greenhouse gases. Projections suggest that with the increase in population and economic development, energy demand is expected to rise by 60% by 2050. The built environment, being responsible global energy consumption and emissions, has an important role in meeting net zero targets. As the demand for built spaces for housing, work and leisure continue to rise, making these spaces energy-efficient is brought into the focus. As the buildings offer untapped energy efficiency potential, it highlights that in the UK alone, they are responsible for 25% of emissions and consume 39% of energy.

With rise in calls for better designs to solve the issue of energy consumption, performance gap between design and operational phases has evolved as a new problem. Mixed-use developments and high-rise buildings recently have gained traction as they offer benefits such as urban density, accessibility, and income diversification. Due to varied load demands, managing energy consumption in mixed-use buildings presents with opportunities and challenges. Using techniques like benchmarking energy use and incorporating microgrid technologies in mixed-use high-rise buildings for energy management provides with an opportunity for research.

This thesis aims to optimise energy management through design strategies in mixed-use high-rise buildings using microgrid technologies. The ‘3D’ framework presented directly reduces Energy Use Intensity of each zone in various mixed-use high-rise building setups and improves the overall impact of microgrid technologies considered. In terms of solar PV, the electricity outputs increased from a mere 6.0-8.8% to 18.6-56.0% while the wind energy outputs increased from 1.1-4.7% to 3.0-30.1%. The research outcomes aim to address energy trilemma issue and guide effective energy use of built environment in meeting net-zero goals while benefiting the local communities.

**Chloë Andrews-Jones**

Chair, Fuellers’ Charitable Trust

1st February 2024