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Abstract

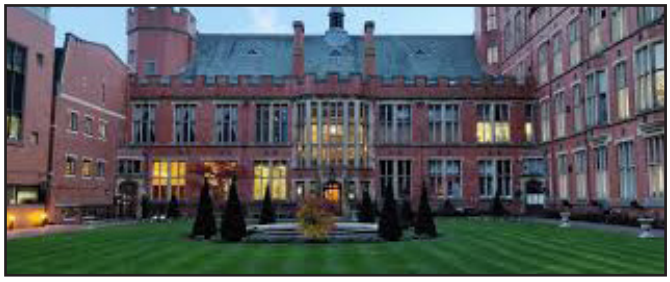
The Potential of Reducing Carbon Emissions by Integrating Urban Water Systems and Renewable Energy Sources at a Community Scale

F Liu[1], S Tait1, A Schellart[1], J Boxall1, M Mayfield[1]

[1]Department of Civil and Structuring Engineering, The University of Sheffield, Sheffield, S1 3JD, UK.

Abstract:

This study presents a novel take on the energy-water nexus, exploring the coupling of local distributed water assets and renewable generation to attempt to replace CO2 emitting residential heat demand. It first explores the opportunity for the generation and storage of renewable energy (potential and heat energy) available within local water distribution and wastewater collection networks. Secondly, it defines the potential reduction in CO2 emissions that could be achieved at a community level, if local wind and solar renewable energy sources can be linked intelligently with the energy storage capabilities of the local water distribution and wastewater collection networks. An integrated system consisting of wind turbines, solar PV panels, a turbine linked to a water service reservoir, a small number of heat pumps linked to the wastewater collection network and a non-renewable source was modelled. A simulation tool is developed to estimate the amount and temporal pattern of energy availability from renewable sources, such as PV, wind, water stored in service reservoirs and heat recovered from sewers. This tool then optimises the mix of energy sources at hourly intervals throughout the year to match residential heat demand, which is a major source of CO2 emissions in the UK. Simulations are run for a community of 1000 UK households for three different locations to test how the renewable energy obtained from the water supply and wastewater collection networks can reduce and replace non-renewable energy. Results show that the integrated water-energy system could satisfy the community residential heat demand for up to 63% of the time in a year for a range of locations in the UK and reducethe associated CO2 by approximately 60%when compared to all heat demand being satisfied by natural gas. On a national scale, the introduction of such intelligent systems could make a significant cut to UK's CO2 emissions. A more detailed analysis of the simulations indicates the renewable configuration that minimises the CO2 emissions can reliably meet the residential heat demand in the



summer. This work shows that integrating water and energy systems at city and neighbourhood scale can bring significant economic and environmental benefits, and may be an approach that would help the UK meet its CO2 emission obligations by substantiallyreducing the18% of CO2 emission (currently estimated to be) related to domestic heat use.

Biography:

Fei Liu is currently a postdoc at the University of Sheffield working on the Twenty65 project, with a research focus on water-energy system modelling. In particular, she is interested in exploring if distributed water infrastructure can work as a part of an integrated energy system, with more traditional renewable energy sources to help reduce carbon emissions at a local scale. She moved from China to the UK as a teenager, where she then obtained a BSc in Mathematics and later on a PhD in Operational Research and Management with a focus on energy system optimisation, both at the University of Warwick.Fei has been very active in energy research and has presented in various international conferences such as Sustainable Development of Energy, Water and Environment Systems, IWA Symposium on Modelling and Integrated Assessment, and Offshore Energy and Storage Symposium.

Publication of speakers:

1. Shu, C., Zhou, K. Z., Xiao, Y., & Gao, S. (2016). How green management influences product innovation in china: The role of institutional benefits. Journal of Business Ethics, 133(3), 471-485.

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