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Supporting Exploratory Decision Making of Water, Energy and Food Nexus Innovations under Deep Uncertainty

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Exploratory Decision Making of Water, Energy and Food Nexus Innovations under Deep Uncertainty

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Abstract: Water, Energy and Food (WEF) systems exhibit great complexity and are particularly challenging to manage sustainably and in an integrated fashion. Historical sector boundaries and disparate commercial/political agendas may impede the introduction of sustainability initiatives and innovations. Methods to support an explorative decision making process given a range of uncertain future scenarios are needed, as is clear and objective identification of significant impacts on the wider WEF system. Furthermore such methods, if better understood, could be widely adopted.

We combine Agent Based Modelling (ABM) and Multi Criteria Analysis (MCA) to assess alternative patterns of action within a given sustainability initiative context. The focus of this study is Anaerobic Digestion (AD), for which effective spatial patterns (number and size of AD facilities) and diffusion rates are sought. The operation of the AD solutions are modelled under various possible future states of world, capturing a fuller depiction of the problem space and hence facilitating more robust decision making. The future state scenarios related to WEF systems have been constructed, based on extensive desk-based research.

We will present the results of a Lincolnshire, UK case study where we consider factors such as household recycling habits, feedstock production, capital, operational and transport costs. Effectiveness is assessed via a set of indicators measuring impact and benefits on WEF nexus function. Tangible benefits relate less to what is produced than what is avoided e.g. landfill emissions, fossil fuel usage, chemical fertiliser demand, and irrigation (pumped water). MCA is used to rank alternative solutions within a scenario, based on decision criteria weightings. Sensitivity analysis is used to reveal issues of uncertainty or instability within the parameter space. Understanding the possible consequences for ABM dynamics is important due to the difficulty in estimating parameter values from literature.

***Keywords**:* Agent Based Modelling; Water, Energy, Food Nexus; Multi Criteria Analysis; Decision Support