# *INCORPORATING NOVEL RENEWABLE ENERGY COOPERATIVES TO SCALE-UP SMART LOCAL ENERGY SYSTEMS FOR UK'S NET ZERO FUTURE*

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## Overview

A potential new approach to accelerate the energy transition to deep decarbonisation is through the scale-up of smart local energy systems (SLES) that combine renewable energy (RE) and smart technologies for system flexibility (Ford et al., 2019). Such a local systems approach will be funded by a range of investor types and enabled by a range of governance institutions (Ford et al., 2019). However, according to our previous study (Li et al., 2020), even with the participation of local investors (e.g. households and municipal utilities), the power system still cannot be fully decarbonised to reach the net-zero emissions target by 2050. New business models should thus be introduced into the market to incentivise or enable local investors to exploit the very large RE potential in all regions across the UK to further scale-up SLES.

Community ownership schemes are new business models that allow collective ownership and management of RE plants and share the revenues from those plants among a community. Consumers who do not want to, or cannot, invest in renewable power plants on their own can do so through community ownership models. Sharing costs means lower upfront investment costs for RE projects. These business models encourage the growth of distributed generation and local RE power plants, contributing to reaching the 2050 decarbonisation targets. In the UK, community ownership models are less developed than in other countries, such as Germany, with around 300 UK community ownership projects active in energy generation but can considerably contribute to the scale-up of RE generation (Braunholtz-Speight et al., 2018). This is thanks to the development of networks of learning within communities, grant funding, and the rise in alternative financing mechanisms like community shares which allow finance to be raised from the general public.

This study thus aims to assess the role of cooperatives, which are based on the community ownership, in the scale-up of SLES to increase the share of RE to decarbonise the UK electricity system. The key novelty of this study is that local cooperatives can access household finance to benefit from economies of scale when investing in RE (e.g. onshore wind and solar PV) and subsequently expand their business model to allow households to access policy mechanisms. As cooperatives get bigger, households can even contribute to the development of offshore wind via cooperatives. The modelling then investigates how the rest of the market reacts to these cooperatives, both competing against them and copying their business model.

## Methods

To better represent the UK electricity market, we used **BRAIN-Energy, an ABM of electricity generation and investment**, incorporating agents with heterogeneous strategies and bounded-rationality in their investment decisions and multi-agent interactions (Barazza & Strachan, 2020). The UK electricity sector in BRAIN-Energy is divided into three regions (London, Scotland and the rest of the UK) because the potential of RE technologies varies across different regions. Two types of agents, **investor and policy agents**, are incorporated in BRAIN-Energy. There are national (incumbent utilities and new entrants) and local (municipal utilities and households) investor agents, and they participate in the electricity market based on their own heterogeneous strategies, financial endowments and risk-return considerations. Policy agents comprise the national government (which subsidises investment into new RE assets and enforces a $CO_2$ price and interim decarbonisation targets), the national regulator (which manages security of supply by holding capacity auctions), and local governments. Investor agents in BRAIN-Energy base their **investment decisions** on an NPV calculation. The investors' bounded-rationality is reflected in their limited foresight of the future and heterogeneous expectations about future electricity prices and the level of electricity demand. Moreover, investors have different discount rates and return expectations.

In this study, we further extended the BRAIN-Energy model by adding **new RE cooperative agents,** which are established by local community members. These agents adopt a more flexible investment strategy to compete and grow in the market, as shown in Figure 1. In the beginning, with limited capital, these cooperatives focus on developing local RE projects to scale-up SLES, leveraging their strong connections in local regions. They can recruit households to buy shares and so invest in RE without the need to manage any technical hurdles. Households might be more willing to participate in the system transition in this financial way.

## Results

Four scenarios (i.e. no-cooperative, weak-cooperative, strong-cooperative, and cooperative-partnership) were investigated to understand the influences of the financial capacity of cooperatives– as locally based investor-actors with the potential to leverage household finance to make SLES into a major market player across the UK – and the role of government's interventions on the transition of the UK electricity system. In the cooperative-partnership scenario, the national government plays a more active role in the electricity market by setting an electricity price floor to tackle the "missing money problem"(Winkler et al., 2016) so that the value of system security can be reflected. Moreover, new entrants with robust financial resources copy the cooperative's successful SLES business model and can decide to join and further amplify the SLES market.

Annual GHG emissions (Figure 2) are driven by the generation mix and hence have a clear association with the rising profile of RE over the modelling horizon. In all four scenarios, carbon budgets (in carbon intensity) are imposed on the power system; this means dropping to 50 gCO2/kWh by 2035, followed by full decarbonisation by 2050. With a lower share of RE in the no-cooperative case, annual GHG emissions remain at the highest level and are at least 30% higher than in the other cases, meeting net-zero targets only in 2054. The active investments in RE plants by both weak- and strong-cooperatives do help considerably reduce GHG emissions over the complete time horizon. Nonetheless, even though the strong-cooperative can reduce GHG emissions to around 10 Mt CO2e in the 2030s and close to zero emissions by 2045, there is a large jump in GHG emissions approaching 2050 due to the shortage of new investments prior to 2050, as discussed above. The reliance on electricity provision from gas power plants to meet the demands then leads to the peak in GHG emissions. As investors recover their financial health, their heavy investments in RE in a dash for market dominance swiftly bring down GHG emissions to net-zero around 2053. Annual GHG emissions for the cooperative-partnership scenario are similar to those in the cases of weak-cooperative and strong-cooperative before 2040 when these three scenarios have a similar share of RE. However, the cooperative-partnership case is the only one to keep reducing its GHG emissions and reaches net-zero emissions by around 2043, which is about 10 years earlier than all the other cases. This is because sufficient capacity of RE is introduced by new entrants from 2040 to avoid the reactivation of gas power plants around 2050. The remaining nuclear also aids earlier full decarbonisation before the share of RE reaches 100% around 2052. Achieving net-zero electricity GHG emissions earlier is critical for the decarbonisation of the transport and buildings sectors and the overall achievement of the UK's net-zero goals (CCC, 2020).

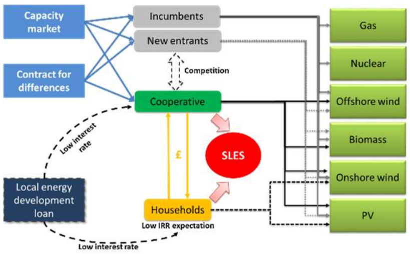


Figure 1 Investment behaviours in the market

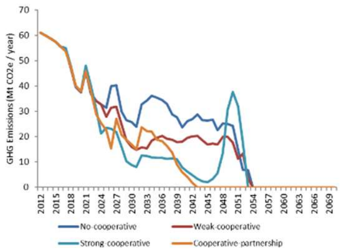


Figure 2 Annual GHG emissions

## Conclusions

Key findings are that cooperatives can have a major impact on both the scale-up of SLES and overall national efforts to decarbonise the electricity sector. The role of local cooperatives is boosted when they have access to a larger pool of cheap household capital to enable them to quickly grow their RE portfolios and become national players. And in the long-term, when cooperative financial strength is tied up in existing renewable investments, new entrants – underpinned by a continued minimum level of government support – can copy the cooperatives' business model and complete the energy transition to net-zero carbon emissions.

Hence, it is essential to introduce new cooperatives that focus on scaling-up SLES and RE and provide them with flexible financial strategies that allow them to grow, supported by strong interventions from active governments. Only in this way can the power system be decarbonised effectively and reach net-zero emissions even before 2050, as deemed crucial for the net-zero transition of the energy system (CCC, 2020).

## References


Barazza, E., & Strachan, N. (2020). The impact of heterogeneous market players with bounded-rationality on the electricity sector low-carbon transition. *Energy Policy*, *138*(March 2019), 111274. https://linkinghub.elsevier.com/retrieve/pii/S0301421520300343

Braunholtz-Speight, T., Mander, S., Hannon, M., Hardy, J., McLachlan, C., Manderson, E., & Sharmina, M. (2018). Evolution of Community Energy in the UK. In *UKERC* (Vol. 5, Issue September).

CCC. (2020). The Sixth Carbon Budget: The UK's path to Net Zero. In *TCommittee on Climate Change, London* (Issue December). https://www.theccc.org.uk/publication/sixth-carbon-budget/

Ford, R., Maidment, C., Fell, M., Vigurs, C., & Morris, M. (2019). A framework for understanding and conceptualising smart local energy systems. In *EnergyREV, University of Strathclyde Publishing, UK*.

Li, P.-H., Barazza, E., & Strachan, N. (2020). *Early insights into the non optimal investment outcomes in the scale-up of smart local energy systems*.

Winkler, J., Gaio, A., Pfluger, B., & Ragwitz, M. (2016). Impact of renewables on electricity markets – Do support schemes matter? *Energy Policy*, *93*, 157–167. https://doi.org/10.1016/j.enpol.2016.02.049