

Incorporating Novel Renewable Energy Cooperatives to Scale-up Smart Local Energy Systems for UK's Net Zero Future

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43rd IAEE, Tokyo, Japan

3rd August 2022



UK's Net Zero Targets



Paris Agreement (COP21, 2015):

...keeping a *global temperature rise this century well below 2 degrees Celsius* ... even further to *1.5 degrees Celsius*.

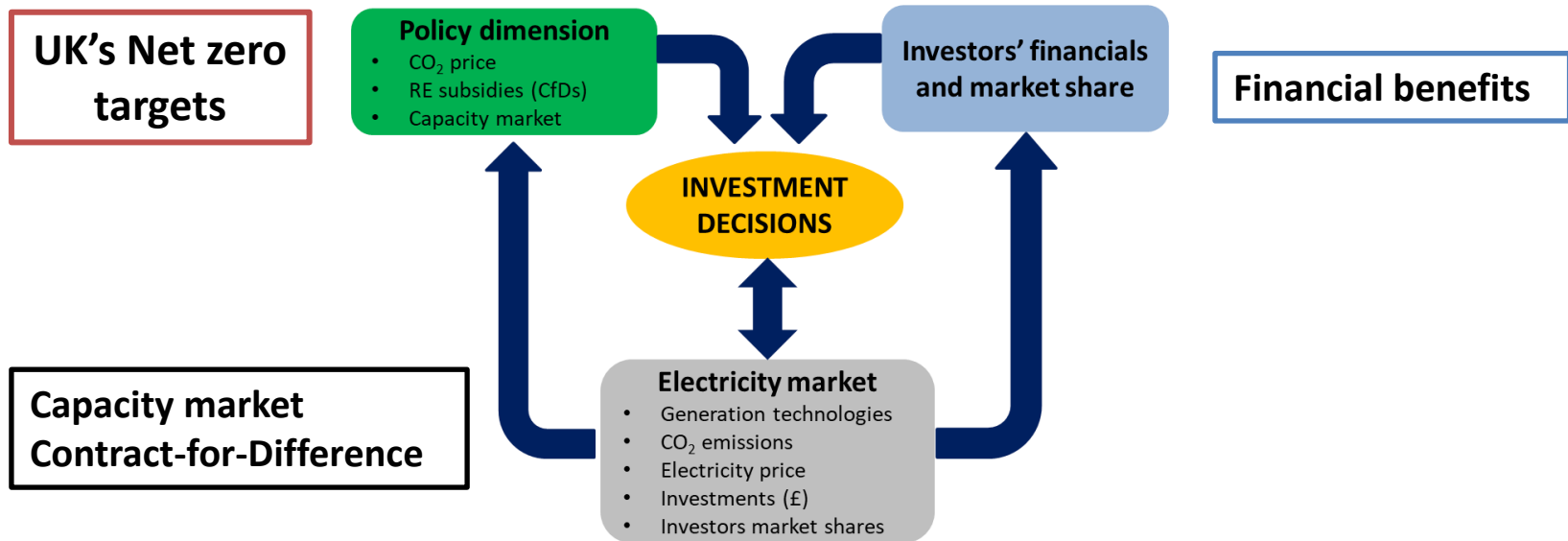
- **UK low-carbon targets:**

- **Climate Change Act 2008: 80% reduction** on the levels of 1990 by 2050
- In 2019, UK passed legislations to end its contribution to global warming by 2050. (**net-zero emissions**)
- In **UK's Net Zero Strategy (BEIS, 2021)**, the government has committed to fully decarbonise the power sector by **2035!!**

- The power sector contributes to **~16%** of total CO2 emissions in 2021
- UK electricity market has been fully liberalised since early 1990s
- **Smart local energy systems (SLES)** (Ford et al., 2020) might accelerate the power system decarbonization due to **the expansion and diversification of investor base** (Braunholtz-Speight et al., 2020; McInerney and Bunn, 2019)



Challenges in Decarbonisation of Electricity Market



- **Investors' investment decisions might not be in line with net zero targets:**

- **Financial expectations:** Different discount rates and return expectations
- **Bounded-rationality:** reflected in limited foresight of the future and heterogeneous expectations
- **Experience:** Past-experience (self-learning) and imitation of other investors' successful strategies

- Hence, investment decisions are **heterogeneous, non-optimal and myopic**

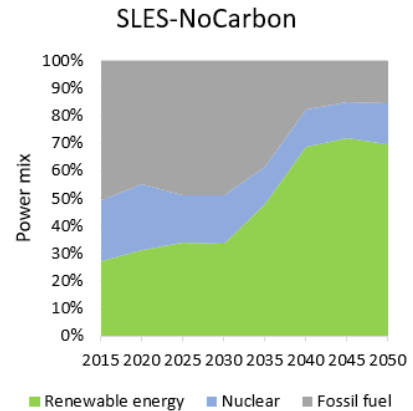
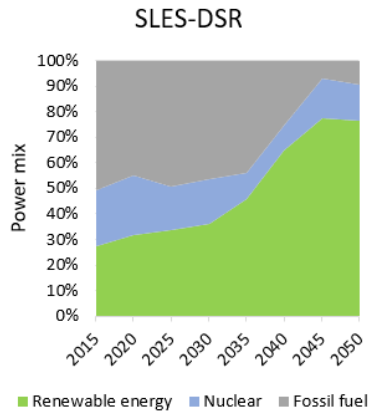
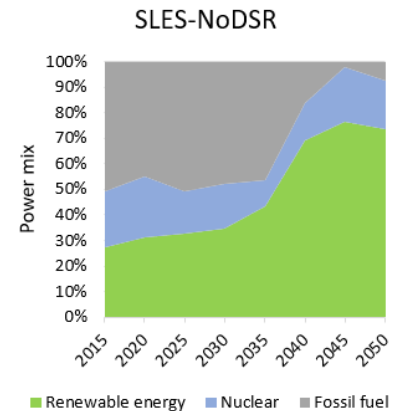
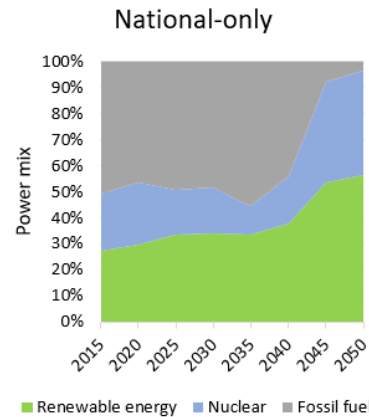


Findings from Our Previous Study

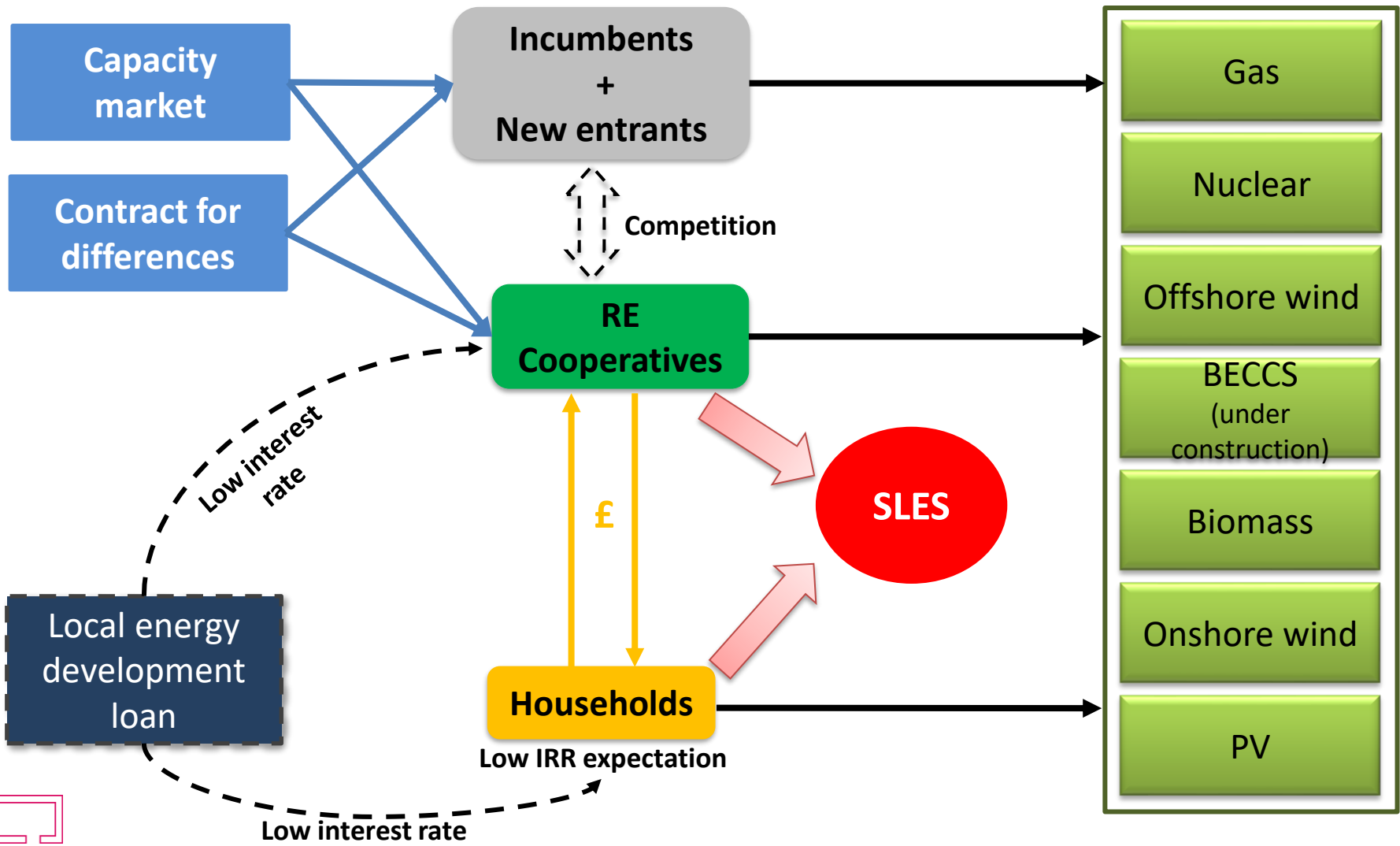
- UCL Energy Institute’s **BRAIN-Energy model (ABM)** is applied.
- The **deploy of SLES** can scale-up RE deployment.
- **HOWEVER**, It is still difficult to reach net zero targets by 2050.
- **Novel business models** are desirable!!



Local investors are considered

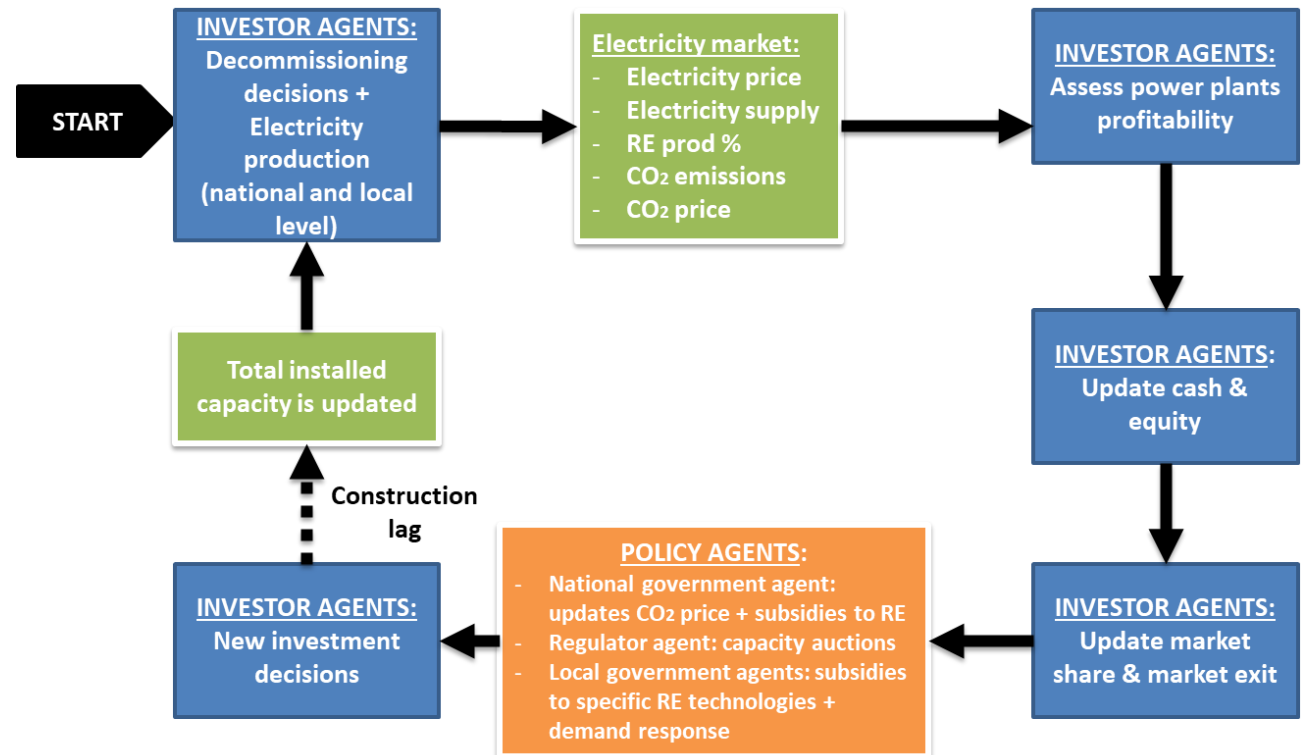
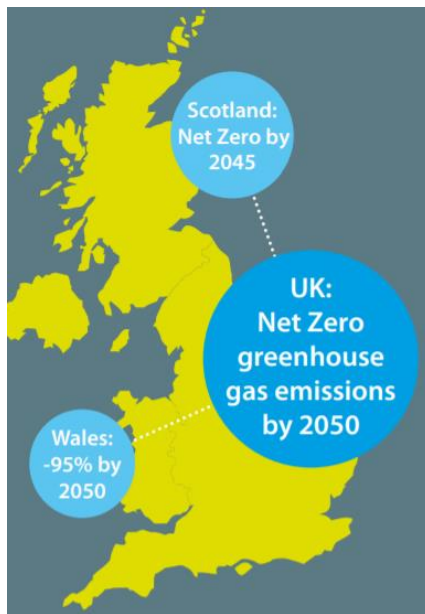


Potential Role of the novel RE cooperatives



BRAIN-Energy Model

- BRAIN-Energy model is a novel ABM to evaluate the influences of investment strategies on the long-term decarbonisation of the UK power system.
- Explicit representation of individual agents
- Interaction between agents
- First ABM to integrate Smart Local Energy Systems (SLES).



Agents: Governments and Regulators

- **Aims of government and regulator agents:**
 - System stability
 - Long-term decarbonisation
 - affordability

Policy agents	Region, number & aim	Policy instrument
National government	1 national agent. Aim: to decarbonise the UK power sector, by encouraging new investments in renewable energy plants.	CO₂ price Contracts for Difference (CfDs): for RE technologies
Regulator	1 national agent. Aim: to promote security of supply by encouraging investments in gas and nuclear power plants	Capacity market: to promote security of supply by encouraging investments in gas and nuclear
Local government	3 local government agents (one in each region). Aim: to decarbonise local region.	Implicitly subsidises technologies through guaranteeing they receive electricity prices set at the national level



Agents: National and Local Investors

- Aim of investor agents:
 - Pursuit profits from their investments

Investor agents		Region and number	Technology
National	Incumbent utility	2 national agents	All: nuclear, gas, biomass, PV, onshore- and offshore wind
	New-entrant	2 national agents	Renewable energy only: biomass, PV, onshore- and offshore wind
Local	Municipal utility	1 in London region, 1 in Scotland region, 1 in the rest of UK region	<ul style="list-style-type: none"> • London: PV • Scotland and the rest of UK: biomass, PV, onshore and offshore wind
	Household	1 in London region, 1 in Scotland region, 1 in the rest of UK region	<ul style="list-style-type: none"> • London: PV • Scotland and the rest of UK: PV and onshore wind
	RE Cooperatives	1 in London region, 1 in Scotland region, 1 in the rest of UK region	Renewable energy only: biomass, PV, onshore- and offshore wind



Scenarios

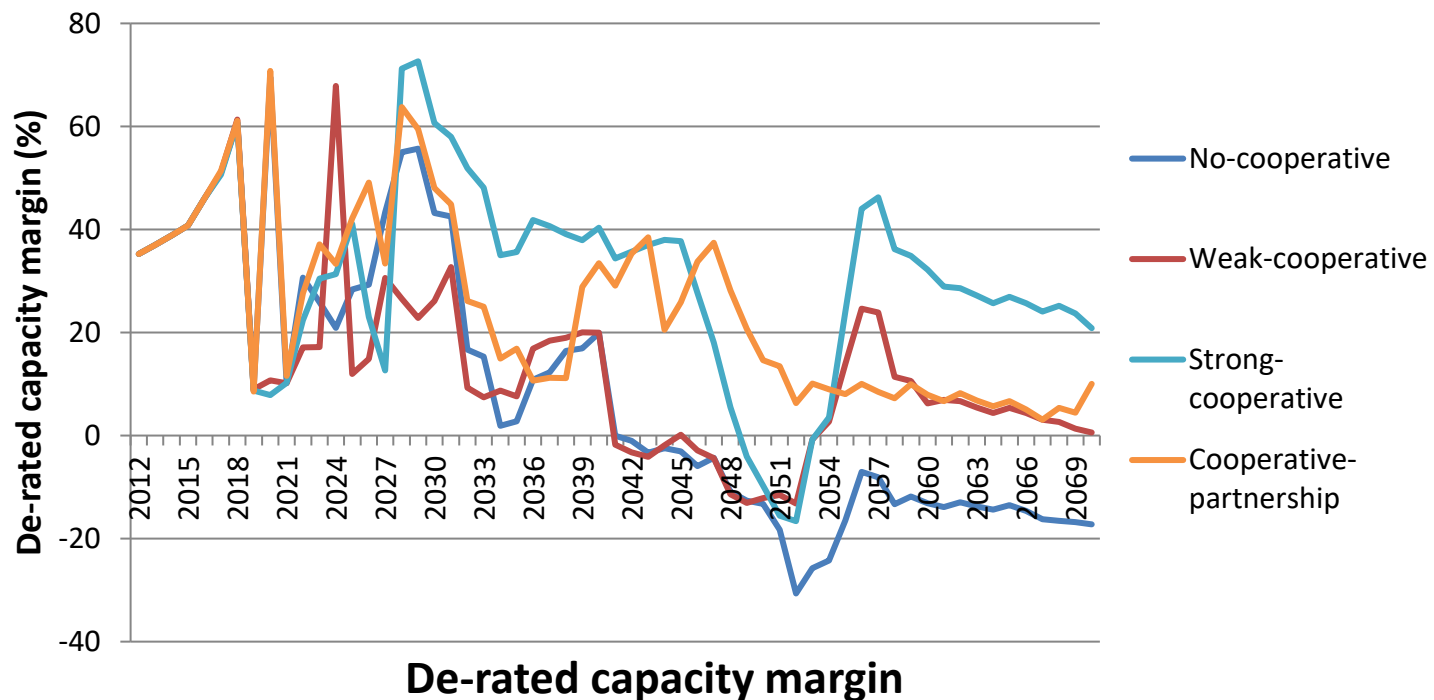
- Investigate the influences of
 - RE cooperatives,
 - Investment strategies, and
 - Government's strong interventions

Scenario	Investor	Cooperative's financial capacity	Additional market and policy support
No-cooperative	National and local investors	N/A	No
Weak-cooperative	National, local investors and RE cooperatives	Expensive capital from banks (6%)	No
Strong-cooperative	National, local investors and RE cooperatives	Cheap capital from banks (1.5%); <u>gathering capital from households</u>	No
Cooperative-partnership	National, local investors and RE cooperatives	Cheap capital from banks (1.5%); <u>gathering capital from households</u>	New entrants from 2040; <u>electricity price floor</u>



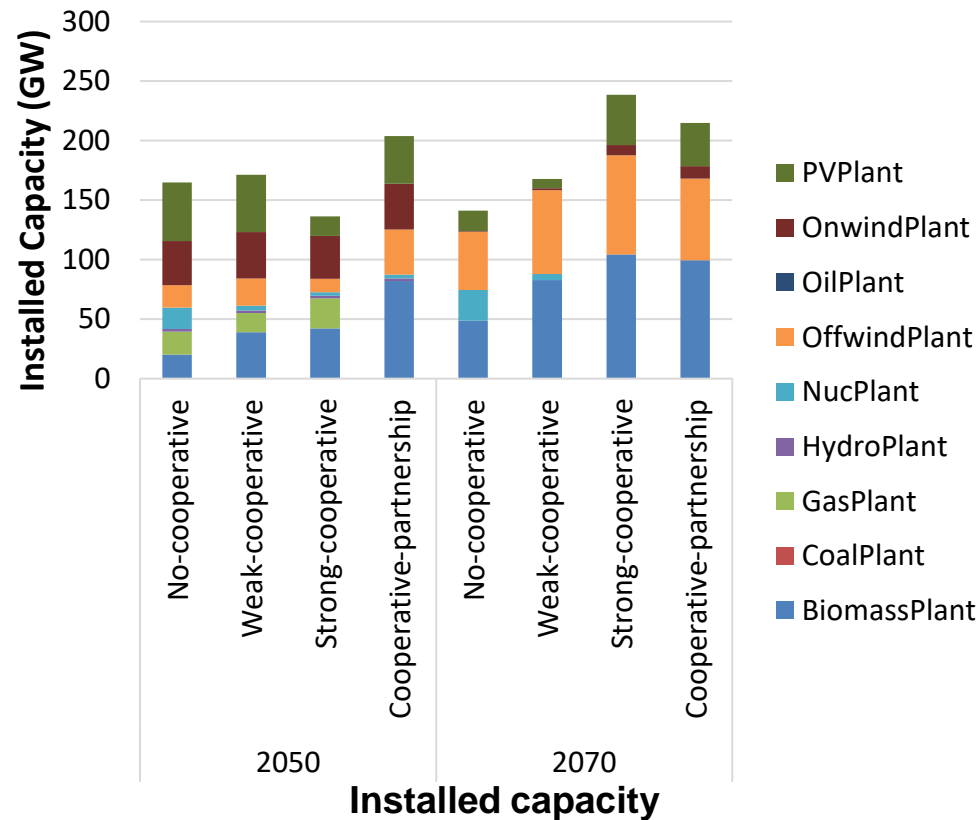
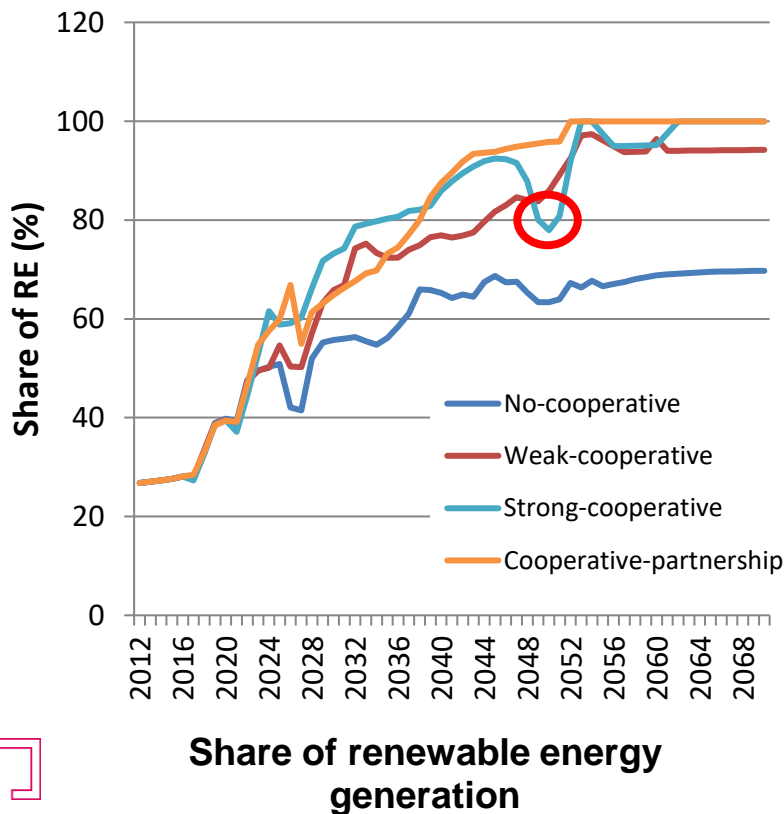
Cooperatives and new entrants can ensure system security

- All scenarios show evident “investment cycles”
- It is challenging to ensure **system security** approaching 2050
 - Sharp increase in **electricity demand**
 - **Decommissioning** of existing power plants
 - Investors’ incapability in investing in new power plants due to their **debt**



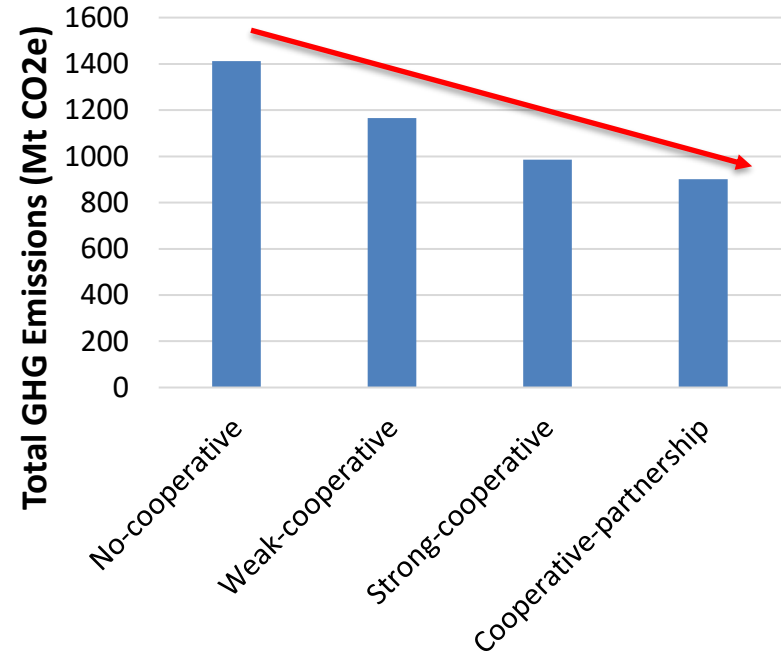
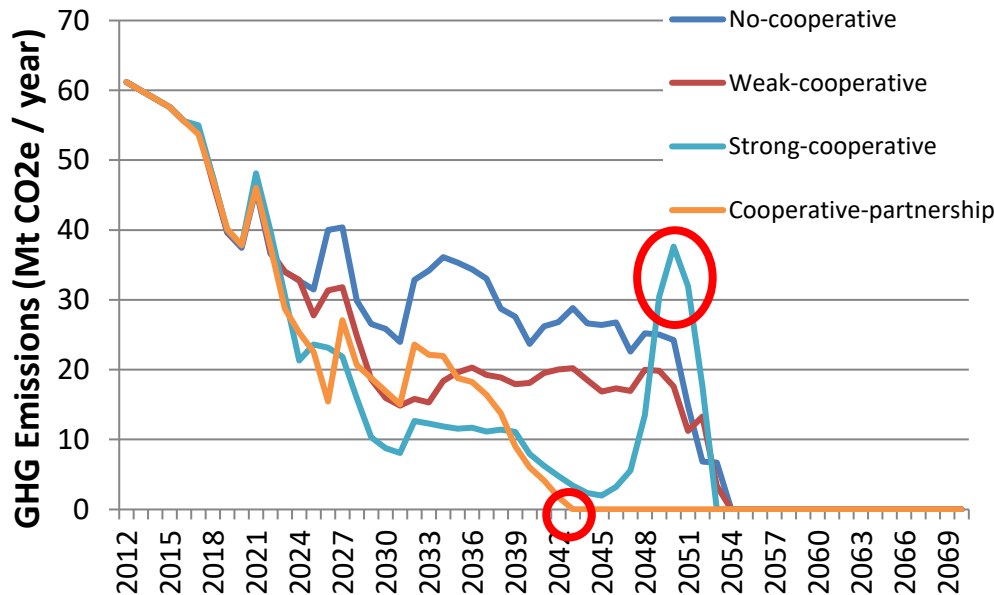
Cooperatives can further boost investments in RE

- **With cooperatives:** share of RE increases from **70%** to **> 95%**
- **Brief drop in strong-cooperative scenario:** cooperatives run out of cheap capital
- **Technology mix:**
 - Investors' preference
 - The scale-up of cooperatives enables them to invest in biomass and offshore



Cooperatives can accelerate emission reductions to fully decarbonise the power sector by 2050 or earlier

- Reduction in GHG emissions is associated with **RE deployment**.
- **Strong-cooperative scenario: a large jump in GHG emission around 2050** due to the shortage of new investments prior to 2050
- Cooperative-partnership scenario **reaches net zero targets around 2043!!**
 - **Strong investments in RE** made by investors incentivised by the government
 - **Nuclear** also helps for the early full-decarbonisation.



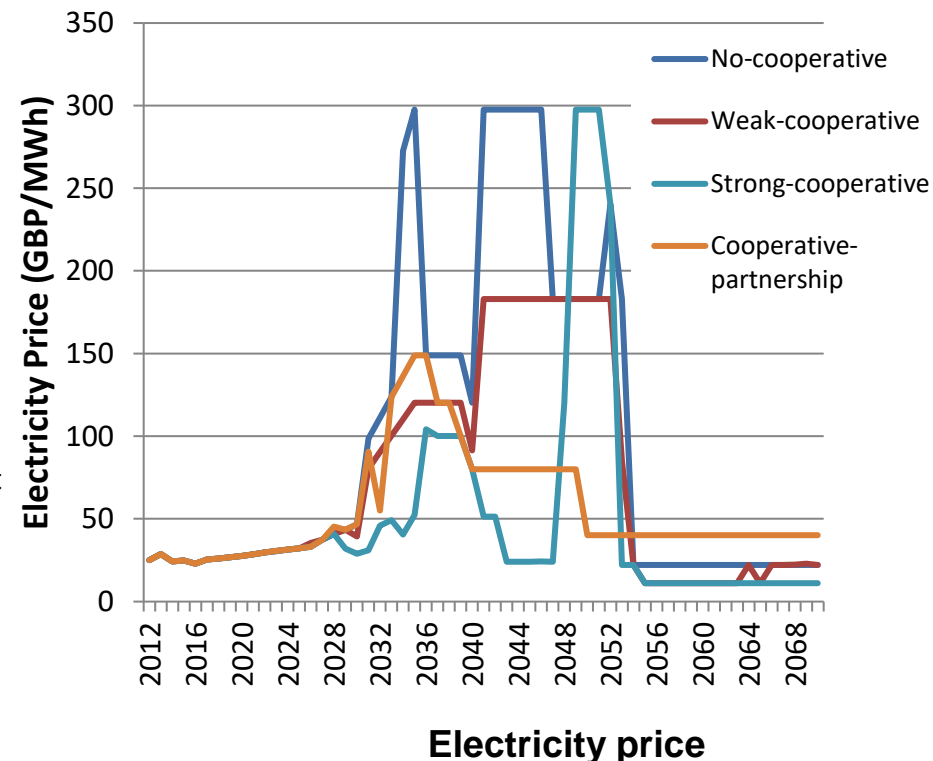
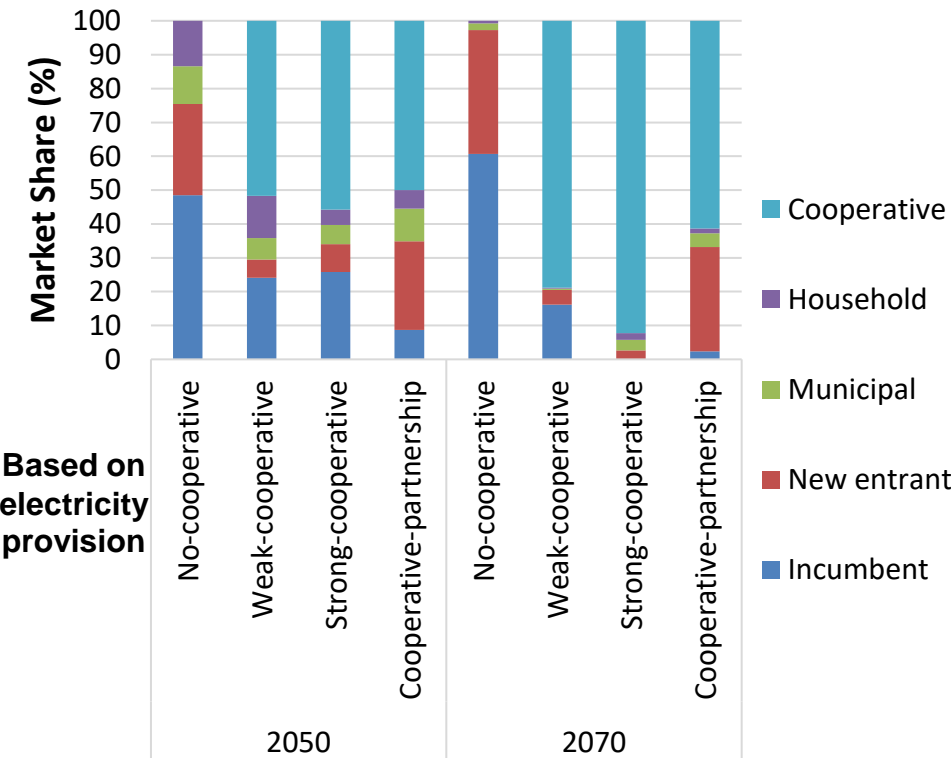
Annual GHG emissions

Cumulative GHG emissions



Growing dominance of cooperatives in the market

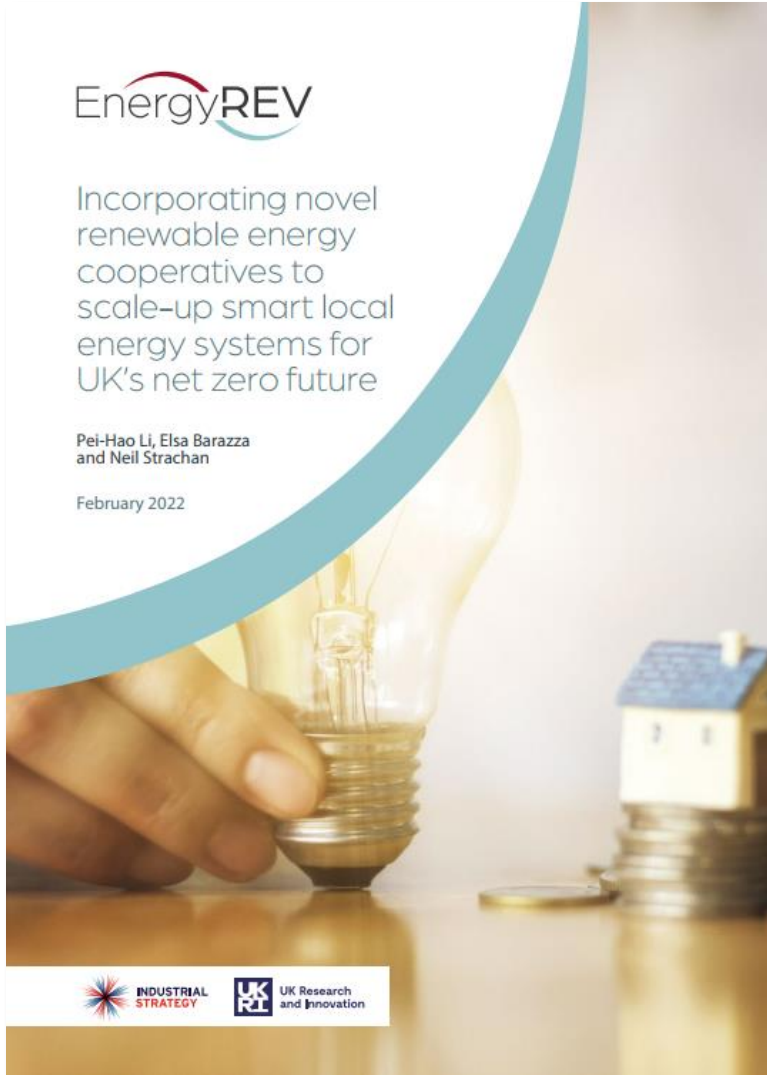
- **No-cooperative scenario:** local investors diminish over time.
- **Weak- and strong-cooperative scenarios:** cooperatives dominate due to their flexible investment strategies.
- **Cooperative-partnership:** timely participation of new entrants plays a key role in power system decarbonisation.
- **Volatility of electricity prices** is evident, except for the last scenario!



Key Insights

1. The electricity decarbonisation **transition will not be smooth.**
2. **Investment cycles** of investors have significant impacts on system security.
3. **Novel business models** are required to unlock the potential of local RE to scale-up SLES.
4. **Cooperatives must go national** to be sufficient to decarbonise the power sector.
5. **Government's active interventions remain essential** to accelerate the decarbonisation of the power sector for net zero targets.
6. **A spectrum of investors** play key roles in transforming the power sector.





Thanks for your attention!!

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<https://www.energyrev.org.uk/outputs/insights-and-tools/incorporating-novel-renewable-energy-cooperatives-to-scale-up-smart-local-energy-systems-for-uk-s-net-zero-future/>

