# Quantifying the social potential of community-based energy cooperatives to contribute to EU-28 climate and renewable energy targets

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## Overview

The EU's main greehouse gas (GHG) emission reduction efforts concentrate primarily on reducing the carbon intensity of its energy system through the deployment of renewable energy generation capacity, among other solutions. Looking ahead, the EU aims to reach its 2030 climate and renewable energy targets through a "citizen-driven" and "consumer-oriented" low-carbon energy transition [2]. Within this context, the adoption of collective investment schemes in renewable energy cooperatives, emerges as an innovative and transformative tool for catalysing the participation of individual citizens and local communities in decarbonising Europe's energy system [3]. However, despite a large literature regarding energy cooperatives, no efforts have been made to quantify – yet alone monetise – the potential contributions that community investment schemes can have on EU GHG emission reduction and renewable energy targets.

This research is the first to attempt a quantification of the potential of energy cooperatives for contributing to the EU's energy transition. The paper focuses on the 'social potential' of community investment schemes to contribute funds for the deployment of distrubted renewable energy generation capacity in the form of community-administered wind farm cooperatives. Social potential in this paper is mathematically defined as the total amount of funds and participation rates for community investments that are feasible, in a hypothetical situation where citizens across the EU-28 have easy access to trust-worthy, visible cooperative investment opportunities. Social potential is thus distinguished from technical (or theoretical) potentials, which could deal with the feasibility of integrating distributed wind energy into the power grid and any geographic, policy, or physical constraints that are relevant to the system. The analysis herein does not deal with these constraints, and thus assumes that they are not binding with respect to the estimated levels of social potential.

We develop a novel probabilitstic simulation technique called 'survey-based social simulation' (SBSS), based on choice experiment responses from all EU-28 nations. Using SBSS this research shows that the social potential for energy cooperatives is substantial, but that community investment schemes will need to be augmented by other measures to reach EU renewable energy and GHG emission targets.

## Methods

This research uses data obtained from a representative choice experiment conducted across all EU-28, which presented respondents with choice scenarios where they could choose to invest a randomly-assigned sum in a community renewable energy scheme with specified characteristics or opt-out of the investment opportunity. The varying attributes of the choice experiment included the rate of return on the investment, the holding period until the invested funds become liquid, the administrator of the investment, solar vs. wind technology, the visibility of the installation, and the amount of money required for an individual to join the cooperative. We then estimate a multinomial logit probability model to identify the optimal combination of these attributes that give the highest probability that a respondent chooses to invest in the offered investment option. In the case of the EU-28, the optimal option is a wind farm that is visible to respondents, and is administered by a community organization. The holding period of the investment funds is set at 20 years, reflecting the average life-span of a wind turbine, and the rate of return is calculated to reflect a market (un-subsidized) return rate based on electricity prices and wind turbine productivity ratings in each nation.

We then employ the SBSS process, which involves using choice model parameter estimates to impute choice probabilities and maximizing some objective function subject to these imputed probabilities. Specifically, using the community investment option characteristics specified above, the probability that the average respondent in each nation accepts this investment option is imputed from country-specific multinomial logit model parameter estimates. We then allow these imputed probabilities of joining a community-based investment to vary as a function of the level of the payment required to join. Maximizing this function analytically yields the social potential for participation, in the form of the expected value of total monetary contributions, in community-based wind farms in each EU-28 nation.

## Results

Results indicate a substantial social potential of over €176 billion that can be realized from individual citizen participation into community-based wind farm initiatives under current market conditions and in the absence of national support mehanisms to renewable energy sources (RES). This equates to the deployment of almost 91 GW of installed wind power capacity across the EU-28, assuming an unweighted average wind turbine installation cost of 1,939 €/kW across the sample nations.

We use country-specific wind turbine productivity ratings to calculate the amount of energy derived from the wind generation capacities that would deployed in every nation if the social potential is acheived. We obtain an aggregated potential of 195,805 GWh per year of energy generated from community-based wind farms across the EU-28. Nation-specific data from [1] are then used to quantify the increase in the RES share in each country's total gross final energy consumption, suggesting an average increase of 8.3% in the consumption of RES across the EU if the social potential is reached.

Finally, we take country-specific carbon intensities derived from the fuel mix of national energy portfolios and substract the emission factor of local electricity generated from the operation of wind power technology. We then multiply the resulting net carbon intensities by the amount of energy generated annually from the total amount of wind capacity installed under the social potential in each nation. This results in annual GHG emission abatement potential of over 103 $MtCO_2e$[1] for the entire EU-28, which translates into a 2.3% reduction in annual EU-28 GHG emissions from 2017 levels.

## Conclusions

The novel social-simulation technique, SBSS, developed in this paper allows for a quantification of the social potential of citizens participating in community renewable energy schemes to contribute to EU renewable energy and GHG targets. The simulation of social potential is subject to various caveats, and most notably assumes that all citizens have access to reliable community investment options. Thus, given the substantial social potential of these schemes estimated herein, creating opportunities for citizens to join such schemes is a key policy reccomendaton from this work. Community investment schemes have only taken off in a select few nations (Germany, and Denmark) and lag behind in other nations. Targeted national/EU energy policies should therefore aim to unlock the social potential of individual citizens through the organization and provison of investment options and a favourable regulatory framework. The results of this study show that such changes would allow individual citizens to act as a legitimate agents co-participating, co-driving, and co-benefitting from Europe's transition towards a collaborative and participatory low-carbon energy system, and contribute significantly to GHG emissions reduction and renewable energy targets.

## References


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[2] European Commission (2019). Clean energy for all Europeans. Retrieved from https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

[3] Haggett, C., & Aitken, M. (2015). Grassroots Energy Innovations: the Role of Community Ownership and Investment. *Current Sustainable Renewable Energy Reports 98* (2).


[1] Million tonnes of carbon dioxide equivalent