Green Transition through Energy Inclusion Communities and DAOs (with appended list of exemplary organizations)

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Abstract

This paper questions the 'prosumeristic' participation of individuals, communities, consumers and citizens in the green energy transition. That is, as often called for, consumers, citizens, individuals, and their groups and communities could become influential decision-makers in energy production systems alongside the traditional model of large energy production and distribution companies. This paper defines a virtual energy inclusion community (VEICO) as a collective entity that leverages Web3-innovations such as decentralized autonomous organizations (DAOs) with the purpose of facilitating equitable participation in energy production and consumption across different socio-economic and geographical landscapes. Such communities purport to align with global sustainability goals and transcend traditional barriers, and to offer a more holistic and democratic approach to energy management. Although energy communities and energy-DAOs, may not result in the achievement all of the renewable energy goals, their potential as catalysts for a more participatory energy market structure may be quite significant. The long-term economic, market and societal potential of energy communities and their role in decentralization merits to be explored. The paper presents the example of Mari, a participant in an hypothetical VEICO, and includes an appendix listing energy-community-enabling DAOs.

Keywords: green energy transition, energy communities, democratic participation, DAO, decentralized autonomous organizations, governance, energy market, technology, smart contracts, renewable energy, climate, community, Virtual Energy Inclusion Community

Introduction

Energy market fluctuations pose challenges for individuals and communities in the global North as well as in the South. The most vulnerable communities and their members are threatened by energy shortages and even outright energy exclusion. Without energy, people are excluded from not only transport, heating, air conditioning, but from democratic participation. Public and private services increasingly demand access to the internet. This is true for financial inclusion, entrepreneurship, health care, education and the labor market so that we can say that socio-economic life relies on a steady and affordable energy supply.

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Energy price hikes, the lack of technical know-how and soaring inflation effectively exclude those that have neither the financial means nor the technological skills to adapt drastic developments. Governments are looking into temporary tax cuts, subsidies, and social and educational support programs for community members to overcome the many challenges and to guarantee the basic rights and freedoms (right to income, work, heated housing, health, social participation, education, basic banking services, freedom of movement etc) that are at stake. Yet, grassroots movements have also been established since it is often felt that governments are not doing enough or that the measures come too late or do not alleviate their inequalities and hardships adequately.

Public governance institutions are also committed to the green transition, to the cutting of non-renewable energy sources, and to a variety of the reductions of the carbon-based economy. However, the cost of renewable energy installations pose an insurmountable challenge to a number of governments and communities, and many looked back into non-renewables when the electricity prices soared in 2021-22. The European Union's (EU) "Fit for 55"[1] package plans to put a carbon emissions premium on the residential sector that further increases energy costs by sector participation in the EU Emissions Trading System (EUETS) as it already does in the field of energy production and distribution industries. The package includes an increase in self-consumption of renewable energies in residential buildings and the number of renewable energy communities - a law which each member state should adopt by 2024.

While tightening the regulatory framework, the EU has also passed regulatory changes that enable the formation of citizen energy communities and renewable energy communities[2] in order to enable and even activate private persons' participation in the energy market.[3] The main goals from the United Nations 17 Sustainable Development Goals (SDGs) package addressed by the energy communities initiative are, in particular: no poverty, affordable and clean energy, reduced inequalities, climate action, life on land and partnerships that all relate to the goals pursued by grassroots energy communities.[4] Thus, the major international institutions' activities highlight the interrelated issues that pose key challenges in the global energy transition.

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[1] https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

[2] J. Lowitzsch, C.E. Hoicka, F.J. van Tulder, Renewable energy communities under the 2019 European Clean Energy Package – Governance model for the energy clusters of the future?, Renewable and Sustainable Energy Reviews, Volume 122, 2020, 109489, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2019.109489. See also Sharma, D., Thompson, A., & Känsälä, K. (2023). EnergyDAO - Decentralised Autonomous Organisation for energy community governance. VTT Technical Research Centre of Finland. VTT White Paper

[3] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

[4] The key EU renewable energy communities directives set out specific criteria to ensure community energy projects can compete in the market based on non-discriminatory and proportional terms. IRENA Coalition for Action (2020), Stimulating investment in community energy: Broadening the ownership of renewables, International Renewable Energy Agency, Abu Dhabi.

Energy Communities utilizing New Technologies?

A typical energy community is one of several households sharing energy production and gains from this production. It is notable, however, that such energy communities are not necessarily connected under the same electricity distributor or may even be located across borders.[5] Although, most typically, they would be locally conceived. Fraga-Lamas & Fernandez-Calames see that decentralized autonomous organizations – utilizing novel digital technologies in furthering governance and global cooperation – could have a key role in solving coordination and trust problems. They call attention to e.g. the Open Innovation agenda (OI2) by the EU to effectively and holistically support SDGs, and point out that the potential of novel digital technologies, such AI and blockchain innovations, should be harnessed for the benefit of the SDGs.[6]

DAOs are an emergent phenomenon utilizing Web3 and blockchain technologies inspired by the so-called free software movement.[7] DAOs are claimed to strive for or, at least, enable a democratic and transparent mode of organization utilizing distributed ledgers and internet Web3 protocols (with decentralized identity, verifiable credentials, permissionless smart contracts) although there are also many DAOs that should better be defined as DACs, i.e. decentralized autonomous corporations. Since legal definitions and criteria are only emerging – and are currently firmly regulated only in a few jurisdictions such as Wyoming, Delaware, Vermont (in the United States) -- DAOs often wrap themselves in the legal framework of a foundation, association or company elsewhere in the world and the classification remains fluid in most parts of the globe.

Despite the ambiguous legal definition, there are already numerous operational DAOs that address the use of renewable energy. One that is of particular interest seeks to enable *'prosumeristic'* participation of citizens in the energy market. That is, as often called for, consumers, citizens and their groups and communities could become influential decision-makers in energy production systems alongside the traditional model of energy production and distribution companies in the lead.

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[5] Binod Prasad Koirala, Elta Koliou, Jonas Friege, Rudi A. Hakvoort, Paulien M. Herder, Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems, Renewable and Sustainable Energy Reviews, Volume 56, 2016, Pages 722-744, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2015.11.080.

[6] Fraga-Lamas & Fernandez Calames 2020, EU 2020

[7] Korhonen, Rantala, Markovich et. al. 2022. "The DAO Listings" - A collection of Past and Present DAO Projects. University of Turku. ISBN: 978-951-29-8801-3, https://urn.fi/URN:ISBN:978-951-29-8801-3

Many energy-DAOs (DAOs that further energy solutions) claim to support numerous green transition goals by way of aligning with the EU renewable energy communities[8] initiative.

Rather than operating based on the internet 2.0 (or Web2) economic logic and e.g. charging a monthly fee, utilizing users´ data profiles for advertising business models, the DAO organisations in the Web3-era have their users participate in the governance and operation of the protocols themselves. Hence, members become kind of shareholders or co-operative participants, who collectively own and govern the platform and the protocol. This is often promoted as an empowerment in that their only option is not to remain passive consumers of a particular commercial service. In principle, decisions approved by DAO-members to act via programmable smart contracts on blockchain are executed with the assistance of technological processes. Typically, the approach is such that a DAO comprises composable pieces of software that connect to one another by use of common protocols and smart contracts. DAOs, including those operating in the energy field, often promote themselves as providing an efficient peer-to-peer trading environment and creating a sense of community, belonging, participation and communal autonomy in, e.g., energy-related issues.

There are DAOs that claim that they enable active participation in climate finance[9] (regenerative finance through smart contracts), technological development (improvements to the platform / protocols are voted on), social aspects and governance of decentralized organizations. These are often multi-jurisdictional, grassroots-based, and they aim to work for the benefit of their members. DAOs utilize digital platforms that are data transparent whilst protecting user privacy offering bookkeeping and process automation capabilities through secure smart contracts.[10] Examples of these technical capabilities allegedly enable a more equitable participation in cross-border renewable energy communities. Although the EU's electricity grids are not fully interconnected and the Energy Communities legislations vary across countries it may be possible to create international virtual energy communities based on such technological, business, and legal innovations.

[8] A renewable energy community (REC) is a legal entity that, based on open and voluntary participation, is controlled by shareholders or members in proximity to its owned renewable energy projects, and consists of natural persons, SMEs, or local authorities. Its primary purpose is to provide environmental, economic, or social benefits to its members or local areas, rather than financial profits. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources. Official Journal of the European Union. L328/82. Accessed on August 12, 2023 at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001

[9] Gibbons, Lisa (2022). What are DAOs and how could they help with climate change and your career? https://www.euronews.com/next/2022/07/06/what-are-daos-and-how-could-they-help-with-climate-change-and-your-career accessed August 12, 2023

[10] In the case of "the DAO" such security was breached. See: Korhonen Outi, Rantala Juho. Value as Potentiality: Blockchain and the Age of Institutional Challenges. Constitutions of Value: Law, Governance, and Political Ecology. 2023.2023

It is of particular interest that the members of many energy-DAOs can be geographically, partially or fully dispersed. It is also possible that participating communities are financially and energy-wise poor. Thus, not only regions rich in renewable green energies can benefit. Through DAO-structures, cooperative avenues could offer inclusion, benefit and equal access to poorer regions and communities. Examples in this international renewable energy project funding realm include DAOEnergy, KlimaDAO, SolarpunkDAO, SparkEco, The Solar Foundation, and HomeDAO, of which each example is very different and its current development of services is in different level of maturity. However, in these cases, there are potential risks that may include technical, business, user-experience and legal obstacles that need further multi-disciplinary, including regulatory, inquiry.

For the purposes of this paper, we define a *virtual energy inclusion community* as a collective entity that leverages Web3-innovations such as DAOs with the purpose of facilitating equitable participation in energy production and consumption across different socio-economic and geographical landscapes. Such communities purport to align with global sustainability goals and transcend traditional barriers, and to offer a more holistic and democratic approach to energy management. Such communities would purport to focus on democratizing energy production and consumption, to align with green transition goals and to enable equitable participation, even in financially and energy poor regions. They often emphasize e.g. collective ownership, governance, and/or empowerment through decentralization, through members directly participating in decision-making. The most active field for grass-roots communities seems to be renewable energy.

Institutional entrepreneurship presents itself as a potential lens through which to study the interaction between DAOs and energy communities in the Nordic context. DiMaggio [11] argued that new institutions arise when organized actors with sufficient resources see in them an opportunity to realize interests that they value highly. This perspective recognizes the complexity of introducing new practices within established institutional frameworks, acknowledging the need for alignment with existing norms, values, and regulatory landscapes. The multi-level and multi-actor approach of institutional entrepreneurship emphasizes the distributed nature of innovation and change, resonating with the decentralized, democratic principles claimed by DAOs. It provides a framework to understand how new practices can be legitimized, integrated, and incentivized within communities, highlighting the dynamic interplay between individuals, organizations, and systems. By focusing on the processes of innovation, mobilization, and structuration across different stages of development, institutional entrepreneurship offers a nuanced and comprehensive understanding of how energy transitions potentially could be guided and achieved.

[11] DiMaggio, P. 1988 'Interest and agency in institutional theory' in Institutional patterns and culture. L. Zucker (ed.), Cambridge, MA: Ballinger Publishing Company: 3–22.

Relevance for Green Transition

Consider the following example: Mari is the head of a Finnish household, who decides to join an energy-DAO that produces green electricity with solar and wind in Spain. The DAO offers to produce half of her household´s electricity consumption. Mari's home is an average Finnish household consuming 7,900 kWh per year whereas the average consumption in Europe is half of that amount.[12] An average Finnish household solar panel system of 5 kWp (16 solar panels) is estimated to produce 4500 kWh. In Spain the production capacity with similar panels is nearly double thus production of 9000 kWh. The reason for this is the higher kW/m2 efficiency in Spain. Spain efficiency is 1,600 kW/m2 and 1,950 kW/m2[13] while the same in Finland ranges between 800–1 000 kWh/m2[14]. In Finland electricity produced emits an average of 48g of CO2 per kWh[15]. One kWh of electricity produced with coal produces 94,6 g of CO2 per kWh. [16] Based on this calculation solar, wind, hydro based electricity saves 48-94,6 g of CO2 per kWh.

Thus half of Mari´s CO2 footprint is 228 kg annually that could potentially be avoided if shared through the energy-DAO's structure. For Mari, participation in a cross-border energy-DAO provides a much higher kWh production compared to an investment in Finland. The socio-economical potential calculated from 10000 households is already significant. Should half of their electricity consumption be available through the energy-DAO, an equivalent of 2280 tons of CO2 would be saved. The annual financial value is 45,000,000 EUR at 0,5€/kWh - with 100,000 households already 450 m EUR. The energy would not be transferred through power grids; instead, it would be sold, possibly tokenized and transferred as market value through the European energy markets.

Similarly to the Mari-example, Matsson[17] concluded that challenges seem to surpass opportunities in the implementation of energy communities in Sweden. This creates an urgent need to understand why this imbalance exists and how it can be addressed. While

[12] Sini Numminen, Salvatore Ruggiero, Mikko Jalas,Locked in flat tariffs? An analysis of electricity retailers' dynamic price offerings and attitudes to consumer engagement in demand response, Applied Energy, Volume 326, 2022, 120002, ISSN 0306-2619, https://doi.org/10.1016/j.apenergy.2022.120002.

[13] In English by Ifema accessed on October 27, 2022 https://www.ifema.es/en/global-mobility-call/sector-news/the-potential-of-solar-energy-in-spain

[14] In Finnish by Motiva accessed on October 27, 2022 https://www.motiva.fi/ratkaisut/uusiutuva_energia/aurinkosahko/aurinkosahkon_perusteet/auringonsateilyn_maara_suomessa#:~:text=Etel%C3%A4isimm%C3%A4ss%C3%A4%20Suomessa%20kokonaiss%C3%A4teilyenergian%20m%C3%A4%C3%A4r%C3%A4%20vaakatasolle,Suomessa%20noin%20790%20kWh%2Fm

[15] According to Fingrid between January 1 2022 and September 30 2022 accessed on October 27, 2022 https://www.fingrid.fi/en/electricity-market-information/real-time-co2-emissions-estimate/

[16] In English by Volker Quaschring accessed on October 27, 2022 https://www.volker-quaschning.de/datserv/CO2-spez/index_e.php

[17] Matsson, Ola. The potential role of energy communities in Sweden. Student papers. Lunds Universitet. 2021.

recognizing the challenges, there seems to be very limited exploration of innovative solutions such as energy-DAOs that could redefine the balance between challenges and opportunities. DAOs' decentralized nature might offer fresh perspectives and solutions. A very important aspect of inquiry is also how citizens perceive and engage with these communities. Understanding the social barriers or incentives for participation could uncover solutions that make participation and involvement more appealing and effective. In order to address the social aspect fully, further research is needed as to:

- what specific challenges could hinder the success of energy communities
- How can DAOs, with claims to decentralized and democratic structure, address these challenges and create new opportunities
- Are there lessons from other Nordic, European or African countries that could inform comparative research

Matsson (2021)[18] also concluded that other tools such as individual micro-production can fulfill environmental benefits similar to energy communities. Assessing where DAOs can be most effective will help identify the best strategies. Studies exploring energy communities and alternative tools is scarce. There is little relevant research on the role of DAOs and the novel technologies that they utilize including blockchain technology. Matsson also noted misalignment in business sectors and advocacy groups. These could potentially hinder energy communities. Understanding diverging perspectives is crucial. Researching how to involve grassroots participation, considering social aspects and the potential of e.g. DAOs and other novel organizational models for them is important. And interesting observation is also that often business sectors see more challenges and advocacy groups see more opportunities in energy communities.[19] A deeper understanding of how regulations can either support or hinder e.g. DAO-driven energy communities is critical. Although energy communities and energy-DAOs, may not result in the achievement all of the renewable energy goals, their potential as catalysts for a more participatory energy market structure may be quite significant. The long-term economic, market and societal potential of energy communities and their role in decentralization merits to be explored.

Energy communities may operate as tools of decentralization of energy monopolies and markets. If so, we have to ask if the decentralized governance that such communities would bring would create a more inclusive, human-centric energy market. The social dynamics of decentralization need to be closely questioned.

[18] Matsson, supra. 53.
[19] id. 59.

Appendix 1

Climate DAO listing - A collection of Past and Present DAO Projects

This is a preliminary listing of SDG-supporting DAOs primarily focusing on climate technologies.

A. KlimaDAO
Overview: KlimaDAO operates as a decentralized organization enabling direct participation in the carbon market. Its infrastructure emphasizes accessibility and transparency, providing tools for efficient acquisition and retirement of carbon credits.
Objectives:

- Enable immediate access for project developers to find counterparties for their carbon credits.
- Facilitate secure acquisition of carbon credits using Web3 tools.
- Allow for environmental benefit claims through a retirement infrastructure, eliminating intermediaries.
- Engage token holders in system governance.

B. DAOEnergy
Overview: DAOEnergy plans to govern clean energy exploration and implementation, from installing clean energy power plants to securitizing long-term energy supply contracts.
Objectives:

- Facilitate the process of exploring clean energy opportunities.
- Enable securitization and sale of 20-year energy supply contracts to Financial Agents.
- Distribute profits from operations to token holders within a 12-month period.
- Utilize government subsidies to promote clean energy.

C. SolarpunkDAO
Overview: SolarpunkDAO focuses on funneling capital into solar energy solutions aiming to enable price discovery of positive externalities.
Objectives:

- Enhance the accessibility of capital for solar projects in underserved regions.
- Provide a decentralized mechanism for investment in climate solutions.
- Create a platform for price discovery of environmental benefits.

D. SparkEco and the Solar Foundation
Overview: SparkEco is focused on democratizing renewable energy production by financing small project developers through a Web3-enabled marketplace. Its sister project, The Solar Foundation, shares a complementary mission to fund and accelerate solar energy in underserved communities.

SparkEco Objectives:

- Develop a marketplace for Renewable Energy Certificates (RECs).
- Fractionalize solar energy projects for broader investment opportunities.
- Partner with local stakeholders in emerging markets to identify new projects.

The Solar Foundation Objectives:

- Reinvent the non-profit and NGO model utilizing web3 tools and capabilities.
- Create innovative and sustainable funding models to empower partner communities.
- Enable access to clean energy and provide an ownership stake in deployed solar projects.
- Accelerate solar energy adoption in underserved communities around the world.

E. HomeDAO

Overview: HomeDAO is a project describing itself as a decentralized utility company focusing on sustainable infrastructure projects, backed by the HOME Token ecosystem.

Objectives:

- Streamline the funding of sustainable infrastructure across the globe.
- Directly fund projects, eliminating overhead and traditional utility fees.
- Expand into diverse areas including clean energy, clean water, housing, and education.
- Provide a token backed by real-world sustainability projects and cash flows.

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