Energy Community Avedøre

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Is the project a case of…:

☒ State-initiated co-creation

☐ Entrepreneur-driven co-creation

☐ Grassroots-based co-creation*

**For an elaboration of the typology, please consult the GOGREEN theoretical framework p. 25.*

Integrated case analysis

Before proceeding to the scoring of the GFs, please provide a *3–5 page case analysis* in which you describe the background, history, and national, regional, and local contexts of the case, the problems and goals addressed by the local collaboration, the participating actors and their relationships, the unfolding of the co-creation process, the most important governance factors (this may include factors other than those in focus in this project), and the generated outputs and outcomes. The conclusion may specify a few lessons learned from the case study.

1) Background, history, and national, regional, and local contexts of the case

Energy Community Avedøre (ECA) is Denmark's first citizen energy community, founded on August 18, 2020, under the name Energifællesskab Avedøre a.m.b.a. The energy community emerged as part of the local development plan called "Avedøre Green City", which was formed in 2018 based on the initiative of a public housing organization in Avedøre Stationsby and the local district heating company – Avedøre Fjernvarme. The initial goal of Avedøre Green City was to coordinate the extensive renovation of the buildings and the district heating system. To this end, Avedøre Green City has to date invested €61 million targeting projects that relate to UN's 17 Sustainable Development Goals (SDGs) and has received €2,6 to support these projects. To this end, sustainable energy has been highlighted as one of the key goals, which has led to the establishment of the energy community in which local stakeholders have collective ownership over the production, distribution, and consumption of electricity. ECA is based around the organizational principles outlined in the new EU directive in 2018 under value-based, non-profit principles, which provides citizens with the opportunity to participate in a climate-friendly transformation of their local energy supplies. The ECA is noticeably evolving in tandem with the emerging Danish regulatory environment pertaining to energy communities, which highlights its exploratory and innovative character.

2) The aims of the project and the sustainability problems that it seeks to address

The initial goal and purpose of ECA as an organizational model is to build a local network for the production, distribution and consumption of sustainable energy. Following the principles outlined in the EU directive, the aim is more concretely to leverage the ECA by building a range of local energy

infrastructure projects, such as electric charging station, batteries and solar panels, which allows the local community to be self-sustaining in terms of its energy needs. By relying on its own locally generated energy and due to their non-profit character, ECA furthermore also anticipates lower electricity costs, which in turn can generate a financial surplus that can be reinvested in the further expansion of the local energy infrastructure.

From the perspective of climate politics, the purpose of promoting energy communities is to accelerate the green transition by encouraging decentralized networks of actors (such as local communities) to invest in green energy infrastructure. To this end, ECA aims in the long run to operate as a local aggregator, referring to a system that combines, integrates, monitors, and manages distributed energy resources (e.g. solar panels, batteries, and heat pumps). Through this aggregator system, ECA will optimize the local grid stability and, by extension, contribute to the overall sustainability of the local energy infrastructure. By creating such decentralized energy grids, energy communities will furthermore also offload the pressure from the collective energy grid and ensure that it is run more efficiently, e.g. by using energy that is locally produced rather than transporting them over long distances (transmission losses, infrastructure maintenance costs, energy reliability/security, etc.).

From the perspective of local communities, the purpose of forming and participating in an energy community is to improve local energy efficiency, costs, and consumption through the localized control of energy production, conversion, and consumption timing. Through the further integration of different energy systems, such as electricity and district heating (sectoral coupling), ECA can operate a flexible, localized energy system that can complement regional and national supply networks. This complementary function to the regional and national supply network can be realized by incorporating a mix of self-production and load shifting, which involves coordinating and managing the supply and demand for electricity and heat during peak and non-peak periods. By smoothing peak loads, energy communities can thereby avoid periods of high energy prices when purchasing electricity and heat.

3) The participants and their interaction and communication in and between meetings

The members and founders of Energy Community Avedøre (ECA) consists of local stakeholders from the Avedøre district within Hvidovre Municipality, including:

a) Hvidovre Municipality, in which Avedøre Green City and ECA is located, is a key stakeholder in this process, which is a member of the C40 Cities Climate Leadership Group that has pledged to combat climate change through the reduction of greenhouse gases. Avedøre Green City and ECA have been important organizational levers through which Hvidovre Municipality expects to meet its target of reducing its CO2 emissions by 80% in 2035 and to achieve CO2-neutrality by 2045.
b) Hvidovre Gymnasium is the local high school located in Avedøre established in 1973, which enrolls around 300 students. The high school covers an area of 11,800 sqm, for which reason it has a large amount of available space that can be used for energy infrastructure, such as solar panels
c) Avedøre Landsbylaug is the local umbrella organization representing the interests of the local residential community residing in Avedøre Landsby (the village area). It coordinates and facilitates local events and functions as a representative organization of the local residents to safeguard their interests. To this end, it customarily also acts as a communication channel that issues updates about local affairs, e.g. construction work and large-scale investments related to ECA.

d) Avedøre Boligselskab is a local public housing organization, consisting of three housing departments situated in Avedøre Stationsby, Hvidovre. The housing organization is a member of a larger confederation of housing organizations, KAB, which consists of 32 public housing organizations distributed across 400 housing departments. As a public housing organization, KAB and its members are organized around the principles of resident-led democracy. Furthermore, they are not organized according to profit-making principles, as they do not seek to make a profit from their rental apartments. One of their agendas based on their resident-led democracy, in collaboration with Avedøre Green City, has been to advance sustainability and environment-friendly residential areas.
e) Avedøre Fjernvarme a.m.b.a. is the local district heating organization that is also organized as alimited liability cooperative like ECA. In other words, it implies that both ECA and Avedøre Fjernvarme involve a distributed ownership by the consumers/producers (or prosumers). The organization contributes to the sustainability agenda by offering district heating to Avedøre, which in the future can also be integrated with the electric distribution network through electrification. The interplay between the systems of district heating and the energy community thereby provides the opportunity to create a synergistic relationship, which will potentially further strengthen the robustness and stability of the latter in the long run.
f) Filmbyen, or the Film City, is a film studio complex that houses the production company Zentropa. It is located in a former military base, for which reason several buildings qualify as listed or conservation-worthy buildings
g) EBO Consult A/S act in the capacity as the project facilitators, as they organize the meeting and act as consultants/knowledge brokers that inform the other stakeholders about the operations of ECA

In total, the energy community covers approximately 2 sq. km, supplying energy to 6,000 residents, businesses and institutions. The residents of Avedøre Landsby (village) are represented through Avedøre Landsbylaug, which is a local community organization that participates in the negotiations and collective decision-making processes in ECA on their behalf. During the COVID-19 lockdowns, the meetings were primarily held online but have since then returned to on-site meetings. During meetings, the members deliberate about future investments and the developmental trajectory of the organization. Furthermore, they also receive updates about the organization's advancement and the challenges they face. EBO Consult facilitates these meetings, who have an office located at Hvidovre Gymnasium.

4) How often do they meet, and do they communicate between meetings?

Since ECA is consolidated as a limited liability organization, meetings mainly take place as board meetings between its members. These meetings occur ad hoc, although they are customarily scheduled quarterly (every 3 months). The project facilitator mentioned that they have deliberately minimized the frequency of meetings to avoid overburdening the stakeholders and, in turn, trigger collaborative fatigue. Besides the comprehensive meetings that bring all relevant and affected stakeholders, they regularly gather for board meetings with all the key stakeholders, which have been organized in a blended format (combining both online and on-site participation). The various members have overlapping memberships in various organizational networks, including Avedøre Green City, hence they communicate and coordinate in

multiple organizational contexts. Information is also communicated to the broader community in Avedøre through news updates, which are disseminated through various news and social media channels.

5) The role and forms of knowledge sharing, coordination and joint problem-solving

A crucial element of ECA lies in its promotion of collective ownership, enabling diverse stakeholders to coordinate and make long-term investments for the improvement of the local community. Purchasing solar panels independently would have entailed an opaque process. Filmbyen, for instance, expressed its intention to acquire solar panels, but the process was initially delayed due to uncertainty about which solar panels to purchase and where to source them. Thus, beyond the goal of establishing an energy community, the collaborative nature of ECA ensures that all members can combine their resources and knowledge, leveraging economies of scale.

Filmbyen faced an additional administrative hurdle in obtaining permission to build solar panels, a prolonged process due to its status as "listed buildings." In this regard, ECA played a supportive role in the negotiation process and formulated a comprehensive case for installing solar panels in the local district.

ECA can be viewed as the outcome of a collaborative process within the broader network of Avedøre Green City, following an iterative sequence: (1) citizen meetings were conducted to gather inputs from members and local stakeholders, (2) stakeholder interests were identified and mapped, (3) a joint vision was synthesized and presented to stakeholders, (4) the project was initiated and legally consolidated as a limited liability organization, and (5) funding was secured from relevant institutions and financial sources, including EU financing. Operating as a legally independent entity separate from Avedøre Green City, ECA now conducts its own internal board meetings to coordinate organizational development.

6) The relation between consensus and conflict and the handling of the latter

All members interviewed have expressed that there have been no major/noticeable conflicts within the organization. Part of the reason is possibly due to the win-win situation of ECA, as no member stands to lose from their participation in the organization, unlike other collaborative projects/networks. Another reason is possibly that the collaboration is based on an opt-in process, so local actors that oppose the aims and objectives of ECA have probably not chosen to join it altogether.

Overall, all members unanimously attest to EBO Consult's competency as project facilitators, ensuring a transparent process that has effectively preempted potential conflicts. However, the project has encountered several administrative and legal obstacles in implementing energy communities. For instance, the initial exclusion of the local public housing organization, Avedøre Boligselskab, from the energy community was rooted in the legislation dictating membership criteria, limiting participation to small and medium-sized enterprises. This criterion is designed to prevent larger organizations from exerting undue influence over energy communities, preserving their essence as distributed and democratic entities. Subsequent negotiations with local authorities successfully secured permission for Avedøre Boligselskab to join the organization, underscoring the adaptability and resilience required in navigating regulatory challenges.

Moreover, there exist additional administrative impediments stemming from regulations governing energy distribution and sharing. These regulations necessitate the allocation of energy either among private individuals or within a singular building (land parcel) through a shared primary electricity meter. Consequently, these rules pose challenges for public housing organizations overseeing multiple buildings, preventing them from functioning seamlessly as a unified entity and thereby complicating the legal procedures associated with energy sharing.

Another legal obstacle arises from the predominant management of local energy distribution grids in Denmark by Distribution System Operators (DSOs). These entities are tasked with overseeing the local distribution of electricity and, in certain instances, natural gas. This operational structure inhibits Energy Cooperative Associations (ECAs) from having ownership, leasing, or renting autonomy over their energy grids. Consequently, energy communities, including ECAs, are contingent on the willingness of DSOs to actively collaborate in identifying organizational solutions for their seamless integration into the existing energy grid. This dependence adds an additional layer of complexity to the regulatory landscape surrounding energy initiatives.

All in all, the continuous dialogue between the stakeholders has been an important factor for securing a supportive collaborative environment despite the initial challenges, which has created a general sense of trust towards the collective vision of ECA (further details on the adjustments to organizational ambitions in section 10 on generated outputs and outcomes).

7) The role and form of leadership: lead actor, steering group and/or collective leadership

EBO Consult has been hired to assume the role as a project facilitator. They organize the meetings and set the agenda to ensure that the organization/project accelerates towards its goals. They also coordinate the mobilization of actors, inclusion of potential stakeholders, and the procurement for the infrastructural investments into the project. Because the introduction of the EU directive is relatively new and the jurisdiction is still slowly emerging, EBO Consult also acts as consultants that 'brokers' and 'translates' the technical, legal, and organizational knowhow connected to the establishment of energy communities.

However, the legal ownership structure of ECA is limited liability cooperative. In effect, the private assets of the members are not liable to cover the organization's debts beyond their contribution to the organization. Furthermore, the organization also legally qualifies as an organization that provides a structured and legally binding network for maintaining a membership-based democracy. Thus, while EBO Consult functions as the facilitators to the organization/project, the organization is based formally speaking based on collective leadership as coordinated investments are made to optimize the placement of energy panels.

8) The temporal unfolding of the co-creation process: major shifts and ups and downs

ECA was formally established as a legal organizational entity on August 18, 2020. However, the negotiations for the goals and ambitions for the organization goes back to the introduction of Avedøre Green City in 2018. Since 2020, several waves of infrastructure investments have been made based on the planned investments by ECA. In 2021, EBO Consult entered a partnership with Flexshape, which provides a digital solution that enables energy communities to operate as local energy aggregators

Since August 2021, electric charging stations equipped with 248 solar panel rooftops have been built at Hvidovre Gymnasium. Filmbyen (The Film City) has also installed 372 solar panels during 2023, which reportedly produce 100-120 MWh that effectively covers approximately 25-30% of their total energy consumption. Several more electric charging stations have also been recently installed in November 2023, which also draws upon the sustainable energy generated from the solar panels.

As of December 2023, ECA has started to share electricity between the different members as several barriers have been overcome or mitigated (see subsection 10 below on the generated outputs and outcomes). To function as an aggregator, ECA needs to implement software technology to integrate locally distributed energy resources. As mentioned earlier, an agreement with FlexShape was entered into to build aggregator technology for ECA. Simultaneously, they have developed software facilitating energy sharing among its members. As of December 2023, ECA has acquired the necessary software from the IT software company Enyday, which has allowed the organization to overcome the technological barriers of sharing energy between members of the energy community.

9) The most important governance factors (may include factors other than those in focus in this project)
Regulatory and legal frameworks play a pivotal role as both enabling and constraining factors for the success of energy communities due to the technical intricacies and heavily regulated nature of the field, shaping the parameters within which these communities can operate and innovate. On the one hand, the introduction of the 2018 Energy Directive was a prerequisite for the establishment of ECA as there was no legal precedent or support for such legal entities or organizational entities. Their legal recognition within EU required the Danish government to streamline its own regulation to comply with EU legislation. On the other hand, it is also evident how the emerging legal space governing energy communities is currently also posing several barriers that hinder energy communities for realizing their full potential, e.g. cost structures related to fees and tariffs, regulations about whether energy communities can own/rent/lease energy grids, the permissibility of exchange/trading electricity across land parcels, and so on.

In essence, the regulatory environment was not originally designed to accommodate the organizational dynamics of energy communities. The historical regulatory framework for energy operated on the assumption that large, centralized entities, often mandated as state monopolies, would be the primary operators. This paradigm aimed at ensuring stability and efficiency in energy production, distribution, and consumption, aligning with the prevailing understanding of the sector's technical and operational demands during its early stages. Energy communities differ significantly from the conventional energy model in several key aspects. Unlike the traditional model dominated by large, centralized entities, energy communities embody a decentralized and community-driven approach to energy production, consumption, and management. In conventional models, state-mandated monopolies or large corporations typically control the entire energy supply chain, from production facilities to distribution networks. Energy communities, on the other hand, involve local citizens, cooperatives, or smaller entities coming together in a distributed (decentralized) network to collectively own, produce, aggregate, manage, and consume energy. To accommodate the ownership structures of energy communities, which emphasize a more democratic and participatory model of energy production and consumption, reforms to the regulatory framework of energy systems are necessary.

10) The generated outputs and outcomes

ECA contribute to increasing the share of renewable energy in the overall collective (Danish) energy system. Their emphasis on energy as a shared and limited resource encourages efficient energy utilization and ongoing efforts toward energy conservation. Although the total scope of the energy community is still relatively small, its gradual scaling promises to deliver multiple benefits for Avedøre Green City and beyond. As of January 2024, ECA has pooled resources together to make targeted investments into several solar panel projects. Concretely, the project has so far installed:

a) 11kWp solar panels and accompanied by four 22kW charging stations
b) 101 kWp solar panels at Hvidovre Gymnasium
c) 152.52 kWp solar panels at Filmbyen
d) 8x 24 kW electric charging stations
e) 0.5 MW battery connected to the local data center that will, once fully implemented, manage the data aggregation, grid management, facilitate peer-to-peer energy transactions, energy asset management, and demand and response optimization

To operate a decentralized, local energy community implies that the members share electricity with each other across land parcels. As of December 2023, ECA has started to share/distribute electricity among its different members, although it is still facing cost-related and organizational barriers that still limits the realization of the full range of benefits of energy communities.

a) Cost (tariff and fee) structures: the current regulatory framework compels energy communities to use the collective energy grid insofar as energy communities are prohibited from owning, renting or leasing their own energy grid. As a result, ECA faces additional costs in terms of tariffs and fees, undermining the cost-effectiveness, profitability, and attractiveness of energy communities. According to EBO Consult, the current tariff and fee structure acts as a prohibitive barrier to the overall cost-effectiveness of ECA. However, as these structures evolve to align with the interests and functional requirements of energy communities, realizing the full potential of ECA will become more financially feasible. The successful scaling of the energy community will be contingent upon whether the cost structures will be reformed, as it currently mitigates the potential financial gains from joining the energy community. Also, the current tariffs and fees does not support the potential energy communities has in relation to balancing the collective grid locally and thus supporting the DSOs in the national challenge with large investments in order to implement decentralized and sustainable energy production.
b) Organizational: Efficiency gains for energy communities are only achievable at a minimum scale or critical mass, influencing their effectiveness and viability as an alternative to conventional sources. Energy communities and their local energy grids benefit from economies of scale, leading to cost reductions in infrastructure development, maintenance, and operations. Without reaching a certain size, the grid cannot ensure stability in delivering reliable power to local prosumers and integrating with the collective electricity grid. Optimal trading and allocation of energy/electricity are also unattainable without a sufficiently large grid. Currently, ECA has not reached this critical threshold, making systematic trading and redistribution of energy between different energy assets suboptimal. These considerations are potentially also reflected in the choice of initial energy infrastructure investments in solar panels and charging stations, which can operate as independent energy assets even if they are not integrated into a local, decentralized energy grid.

The full benefits of sharing electricity among the members of the energy community are currently also limited until it has further scaled its portfolio of energy assets.

The generated output can furthermore be construed as the energy community as a stable legal and organizational entity, providing all its members with a shared pool of knowledge and collective bargaining power to plan large-scale investments and procurement of solar panels and electric charging stations, which would have been costly for individual stakeholders to independently obtain. In relation to the collective investments into renewable energy infrastructure and assets, ECA has functioned as an organizational catalyst spearheading the green transformation of Avedøre as it has managed to mobilize multiple key actors (e.g. Filmbyen, Hvidovre Municipality, Avedøre Fjernvarme, and Hvidovre Gymnasium) in the collaborative network.

11) Lessons learned about the conditions for co-creating green solutions

The overriding influence of the regulatory framework pertaining to energy systems shows how specific fields of green solutions and technologies can be counteracted by factors outside the control of the collaborative organization. While the case study scores generally high on several governance factors, it could not produce green outcomes (as of the end of 2023) that were greater than the status quo. It is conceivable that the relevance of regulatory frameworks will also have an overriding influence on other heavily regulated policy areas, e.g. the introduction of new green technologies in other areas that require permits, vetting and, perhaps, legal reforms to realize their full potential.

Another lesson is the intersection between perceived interdependence and trust-building, as it requires a high level of commitment by all participating stakeholders for the energy community to be successful. The reason for this is that energy communities involve long-term investments into energy infrastructure, which require not only strategic foresight but also an enduring commitment not the organization as you cannot expect to recover the costs and make a return on the investment in the immediate future. However, in the case of ECA, the perceived interdependence between the various stakeholders, all of which shared a joint strategic vision and outlook, has been part and parcel in instilling trust within the organization.

Scoring and analysis of governance factors

1. Perceived importance of biosphere conditions

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

Environmental sustainability constitutes one of the key motivational factors for Avedøre Green City as well as several key stakeholders, such as Hvidovre Municipality, Hvidovre Gymnasium, Filmbyen, and Avedøre Fjernvarme. First, Hvidovre Municipality has made comprehensive climate plans to ensure that they can be carbon neutral by 2045, as part of their pledge to the DK2020 project (more details in GF2). To this end, ECA and its anticipated energy efficiency gains and sustainable energy represents a tangible step towards the carbon neutrality goal under the assumption that it can be scaled over time. Second, Hvidovre Gymnasium has a strong focus on climate change and transformation in their educational portfolio, which they believe can be reconciled with their participation in ECA as it demonstrates how democratic mobilization of local community actors can support green politics. Third, Filmbyen (The Film City) recognizes the environmental impact of movie producers and their responsibility in producing sustainable movies. Consequently, they have considered several years prior to their admission to ECA the option of buying solar panels to mitigate their climate impact. Finally, a part of the organizational goals of Avedøre Fjernvarme (District heating) is to provide locally owned district heating that is not only cheap but also environmentally friendly based on long-term, energy-optimizing solutions for heating houses. In conclusion, the sustainability features of the project have been integral to the collaborative process.

For local citizens represented by Avedøre Landsbylaug, various informants have commented that local citizens in the neighborhood have a favorable view of sustainability and climate politics. However, their support for the green transition is conditional upon advancing solutions that tangibly benefit their daily lives. Thus, local citizens have also found an appeal in the promise of lower energy costs, as they realize how green energy produced by the solar panels directly benefits them. The win-win narrative behind lowered costs and local (democratic) ownership has thus created a synergistic relationship between economic, environmental, and democratic motivations that have collectively advanced ECA.

2. Legislation, programs, and formal goals

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The catalyst facilitating the formation of ECA was the European Union Energy Directive in 2018, subsequently incorporated into Danish legislation in 2020. ECA was registered as a legal entity in 2020 based on the emerging legal framework that enshrined and legally recognized energy communities. Above all, the European Union Energy Directive provided the legal scaffolding to organize energy communities as a legal entity, the purpose of which is to mobilize communities and citizens in energy projects to transform the energy system in a sustainable direction. As a vehicle for the green energy transformation, the purpose of energy communities (as a legal entity) is to provide avenues for citizens to collectively own, produce,

aggregate, manage, and consume energy (electricity for citizen energy communities, but possibly also other sources of sustainable energy for renewable energy communities).

The legal recognition and scaffolding of energy communities have been prerequisites for ECA and its collaborative processes, as they have removed barriers for local communities to produce their own energy. In the past, the energy grid and market have been organized as a monopoly due to its designation as a public utility. Electricity grids exhibit natural monopoly characteristics, where it is more efficient and cost-effective to have a single entity managing the infrastructure, as opposed to multiple competing entities. This led to the establishment of regulated monopolies or government-owned utilities to oversee the electricity grid. There are three levels of relevant actors: (a) Energinet as the transmission system operator, which operates the high-voltage transmission grids, (b) the distribution system operators (such as Radius, EnergiMidt) that manage localized/regional distribution low-voltage transmission grids delivering power to end-users, and (c) electricity suppliers from which consumers purchase their electricity organized around market competition conditions. Denmark has gradually undergone a liberalization of its energy markets since the 1990s, introducing market-based dynamics in terms of the selection of electricity suppliers. The introduction of energy communities has resulted in a further decentralization of energy production and consumption, as citizens can now opt for local ownership of energy production rather than purchasing it from other energy suppliers in the private market.

While some types of energy communities have existed in Denmark prior to the Energy Directive in 2018 in the form of cooperatives operating and owning renewable energy projects such as wind turbines, they have not involved the sharing of locally generated electricity but merely refer to the local ownership thereof. The energy communities outlined in the EU energy directive thereby qualitatively differ as they, moreover, legally enshrine the possibility of not only owning but also sharing electricity.

The EU energy directive has compelled the Danish government to reconfigure the regulatory framework to comply with European Union directives. It legally enshrines the right of energy communities to access the energy markets alongside other electricity suppliers and guarantees, in turn, support mechanisms (financial, regulatory, technical) to promote energy communities (see more in GF 9 on blended financingAbove all, legal recognition has provided institutional support to energy communities, aiding the collaborative process entailed by the organizational model as it provides a clear collaborative template for promoting locally distributed energy infrastructure projects.

Another significant national legislation has been the DK2020 plan, constituting a cross-municipality collaborative platform aiming to achieve climate neutrality by 2050. Ninety-seven Danish municipalities partake in the DK2020 plans, of which Hvidovre Municipality is one. Hvidovre Municipality has pledged to reduce its CO2 emissions by, among other things, making buildings more energy-efficient and transforming local energy production to more sustainable sources. In part, this has been realized by the introduction of the district heating system, also a key member of ECA. The DK2020 plan has served as an important catalyst for strengthening the climate agenda in the municipality, which, in turn, has supported and shaped the Avedøre Green City. The latter has notably emphasized citizen participation and co-creation as enablers to the realization of local climate goals and targets; hence, the emergence of ECA can be seen as a byproduct of this institutional impetus underwritten by the municipality.

Finally, ECA has also benefited from the general support accorded to renewable energy projects, as exemplified by Avedøre Fjernvarme (the district heating), which receives support from the local government, e.g., by underwriting or guaranteeing loans. The Danish government has historically played a significant role in promoting and facilitating the development of district heating infrastructure, which is a key component of the country's commitment to sustainable energy and environmental goals. Local governments (such as Hvidovre Municipality) provide a loan guarantee so the district heating organization can secure a loan for its operations. Insofar as ECA is organized around the same legal and organizational principles (as limited liability cooperatives), informants have also noted the importance of the support provided by the local government as part of this broader tradition. All in all, limited liability cooperatives, such as district heating and energy communities, are supported by national programs that allow local governments to provide regulatory support, invest in, or fund their development. The presence of these established legislations and programs (usually overseen by the Danish Energy Agency) has consequently enabled ECA and its collaborative processes.

3. Relative openness of public governance paradigms

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☒ Medium confidence	☒ Documents
☐ 0.66	☐ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

Hvidovre Municipality strategically emphasizes citizen participation and cross-sectoral collaboration as part of its municipal development plans. For instance, their Climate Plan for 2045 recognizes the significance of mobilizing non-state actors to drive its transition towards climate neutrality. To facilitate this, the municipality issues informational leaflets, providing citizens with the necessary knowledge to make informed judgments about projects and enhance transparency. Specifically, the municipality has created a digital platform to gather citizen input on various local development projects, such as determining the placement of electric charging stations and advancing urban renewal plans. In parallel, Avedøre Green City also underscores cross-sectoral partnerships, mobilizing a variety of non-state actors to lead and facilitate green projects in the local area.

The establishment of ECA is partially based on the institutional support of the municipality, a key actor that has invested substantial administrative and financial resources (investment) to support the renewable energy investments. The municipality has played a significant role in enabling cross-sectoral partnerships through the establishment of Avedøre Green City, creating a supportive environment for ECA and cross-sectoral projects to emerge. However, beyond providing the initial catalyst for the project's formation, the municipality has not benefited from targeted initiatives to improve its collaborative process. This is because the project operates as an independent entity (as a limited liability cooperative) and is relatively self-organizing in its current operations. While the municipality represents one of the core stakeholders

with a long-term interest in promoting green energy infrastructure, it is not actively facilitating citizen engagement on behalf of the project.

An additional issue is that, despite the local government's support for ECA, they often encounter legal and bureaucratic barriers that they cannot dismantle, as this authority lies outside their jurisdiction and primarily rests with national authorities, especially the Danish Energy Agency. Consequently, there is a mismatch between the support offered by the municipality and what is required to advance the project.

4. Formalized institutional channels for citizen participation and community mobilization

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The organizational model of the project as a limited liability cooperative has played a significant role in advancing the cooperative movement in Denmark, gaining momentum in the late 19th century. Denmark boasts several large cooperatives, including Arla Foods & Danish Crown (agricultural), Coop (consumer), and Avedøre Fjernvarme (district heating), to name a few. The organizational model aligns with the cooperative movement's principles, enabling democratic decision-making among multiple partners based on distributed ownership. Denmark's rich history with limited liability cooperatives has provided a supportive environment for ECA, benefiting from organizational experience, learning, and a well-established culture of cooperative models. Various informants speculate that the collaborative process has improved through this cooperative model, as key stakeholders feel confident in consolidating the organization as a cooperative legal entity.

Furthermore, ECA mirrors the cooperative model of district heating organizations, which operate based on principles beyond strict economic profit. This implies that economic surpluses are either reinvested to expand the portfolio of sustainable energy infrastructure or to lower prices for its cooperative owners. Consequently, local citizens have a greater sense of trust in the organization's long-term vision, knowing that it differs from for-profit organizations that might prioritize profit over the interests of the local community.

5. Mechanism for ensuring top-down government and bottom-up social accountability

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☒ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The rapid development of ECA has been extensively documented since its inception, as it has been regularly reported in local news, on the webpage and mailing list of Avedøre Green City, and by EBO Consult (the project facilitators). The project has undergone thorough scrutiny as the first energy community established after the introduction of the European Union Energy Directive in 2018. Insofar as the organization represents a groundbreaking socio-technical innovation, it serves as a potential organizational template for other entities to follow. Because of the high level of public visibility of ECA, in part reflected in its extensive news coverage, Hvidovre Municipality has a political stake in its success. However, there are no concrete accountability mechanisms embedded in ECA that require the organization to document or report its progress and operations to the municipality or other higher-level authorities.

Local citizens are updated about the developments of the project through messages delivered by their representative in Avedøre Landsbylaug (the local community organization representing the citizens of Avedøre Landsby), who will customarily forward information through their local social media group. However, several informants have also reported that the level of awareness among residents about the existence and operations of ECA remains relatively limited. Thus, while accountability mechanisms for the local community are present within ECA, they have not constituted a strategic priority.

6. Strategic agenda-setting by means of translation

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☒ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

While the SDGs carry high strategic weight in Avedøre Green City and in the Climate Plan for 2045 in Hvidovre Municipality, their significance within the context of ECA is limited. Key actors declare a basic level of familiarity with the SDGs and express a generally positive attitude towards them. However, they concede that the SDGs do not constitute an organizational cornerstone, as they are not actively mentioned as part of ECA's broader operations. As far as several multiple board members recall, the SDGs have not been mentioned altogether during the board meetings.

Furthermore, several informants argue that residents in the Avedøre Landsby have limited knowledge about the SDGs and, at most, might have passing knowledge of their existence. No efforts have been made by ECA or the local community representatives to leverage the SDGs as a promotional tool to command support or enthusiasm about the energy community's operations.

In conclusion, the SDGs only exist in a latent form within the ECA, serving as a familiar behavioral script known to all the members of the organization, especially institutional actors such as Hvidovre Municipality,

Filmbyen, and Avedøre Fjernvarme). This script could be used as shorthand for communicating a shared interest in advancing sustainability, although all informants concede that it would rather complicate rather than enable the collaborative process of the organization by forcing the SDGs into its deliberative processes.

7. Construction of narratives about successful multi-actor collaboration

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☒ 0.33	☒ Medium confidence	☐ Documents
☐ 0.66	☐ High confidence	☒ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

Avedøre Green City has part of its local development strategy emphasized multi-actor collaboration by inviting various private and civil society actors to participate in a range of projects. However, insofar as these initiatives are still relatively new, they do not seem to have greatly impacted the operations of ECA according to the informants. While all stakeholders interviewed acknowledge the collaborative context of Avedøre Green City, there are no clear evidence of any narratives about multi-actor collaboration having actively circulated and, in turn, supported the collaborative processes of ECA.

In parallel, Avedøre Landsby, which represents the residents participating in ECA, is a small and tight-knit community, which is bound together by strong relationships and common interests because of their social and geographical proximity. While community mobilization within the village is common, they do not have any experience – at least among interviewed informants – with multi-actor collaboration as such.

8. Building or harnessing institutional platforms and arenas

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☒ Medium confidence	☐ Documents
☒ 0.66	☐ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The project facilitators have been allocated a designated working space located in Hvidovre Gymnasium, which has also served as the designated meeting venue. Informants note that, all things considered, the meeting venue has met the functional needs of the board meetings. During the COVID-19 pandemic, the project facilitators transitioned the meetings to online platforms, conducting virtual meetings on various digital platforms (e.g., Microsoft Teams or Zoom). The option for hybrid meetings has remained available post-lockdown, eliciting enthusiasm from several informants for the flexibility it provides in attending the meetings.

Unlike collaborative projects that involve intensive processes of interactive decision-making, ECA primarily revolves around discrete investment choices related to solar panels and other energy infrastructure (such as electric charging stations). The operations and maintenance of the virtual (software) and physical energy infrastructure are handled by EBO Consult and various subcontractors providing technologies for managing the energy community. Due to these factors, the primary purpose of board meetings is to provide (a) information for stakeholders to make decisions on future energy infrastructure investments and (b) updates on project development, administrative, financial, or legal barriers that require attention. Consequently, the need for dedicated institutional platforms or arenas for collaboration is limited, making the governance factor significant but insufficient to qualify as support.

9. Provision of access to blended financing

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

ECA has relied on funding and financing from various public and private actors, significantly shaping its operations. For instance, EBO Consult is partially financed by the European local Energy Assistance (ELENA) initiative, co-financed by €1.2 million for Avedøre Green City, and consequently, ECA. The ELENA work program aims to enhance the energy infrastructure of Avedøre by establishing a Project Development Unit (PDU) in Avedøre Green City, conducting

a) Technical studies and analysis for optimizing district heating investments
b) Energy audits, feasibility and design studies in the blocks, terraced houses and family houses
c) Tenants, stakeholder and community engagement
d) Tendering procedures
e) Financial engineering
f) Monitoring and reporting

The establishment of the energy community is seen as a potential avenue for enhancing local energy infrastructure, with EBO Consult acting as consultants on the project, funded by the European Union. While the EU has contributed to ECA by financing in-kind resources through funding EBO Consult, it has not directly invested in the energy community itself. Additionally, the project has received funds from the financial pool for energy communities as part of the EU's Horizon2020.

The project is also self-financed through a mix of private stakeholders (Filmbyen), the public sector (Hvidovre Kommune), and the civil society sector (Avedøre Fjernvarme), showcasing a diverse blend of financial sources. Notably, Hvidovre Kommune invested DK10 million in solar panels and electric charging stations. This investment aligns with the municipality's broader ambition to accelerate its sustainability transition. The extensive influence of blended financing on the project has supported its collaborative

process in several ways. Firstly, financing EBO Consult as technical experts has been a crucial success criterion for collaboration, acting as knowledge brokers and mitigating knowledge asymmetry among various actors. Secondly, it has created a structure of distributed ownership, allowing different sectoral partners to collaborate. For instance, Filmbyen initially considered independent investment in solar panels but later joined the energy community to benefit from pooling resources (financial, technical, administrative).

10. The capacity to leverage support from authorities to enable local collaboration

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☒ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The project is in collaboration with Hvidovre Municipality, which has invested DKK 10 million in support. Through ongoing dialogue between the municipality and ECA, dedicated bureaucratic personnel have been assigned to tackle legal and administrative challenges. Their responsibilities encompass tasks such as securing permits for solar panel installations, ensuring compliance with building regulations, and navigating jurisdictional requirements for energy communities. Despite these efforts, informants have expressed frustration over the prolonged turnaround time for administrative requests aimed at streamlining processes and obtaining permits, often facing delays of several months. This bureaucratic lag, compounded by the intricate regulatory landscape governing energy infrastructure construction, has led to significant project delays.

However, ECA has not received significant support from higher-level authorities. Notable interaction with higher-level authorities occurred during the consultative process with the Danish Energy Agency regarding the regulatory environment surrounding energy communities. The organizational model of energy communities is still evolving, and ECA, along with EBO Consult and the confederation of energy communities in Denmark (Energifællesskaber Danmark), has engaged in ongoing dialogue with higher-level authorities to mitigate legal and administrative barriers mentioned in the integrated case analysis. Informants have reported that authorities have not been sufficiently responsive or supportive, acting more as gatekeepers than active sources of support. Consequently, the capacity to leverage support from higher-level authorities has been minimal. While authorities have engaged in an active dialogue allowing energy communities to communicate grievances and perceived barriers to operations, they have not implemented major reforms to the regulatory environment in response to the feedback.

11. Inclusion and empowerment of relevant and affected actors

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☒ Medium confidence	☒ Documents
☒ 0.66	☐ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

The primary objective during the inception of the ECA was to admit as many relevant and affected stakeholders as feasible to the collaborative network, with the aim of capitalizing on the benefits of economies of scale. However, several barriers have hindered the inclusion of all relevant and affected stakeholders, as several actors have either faced initial barriers to joining or subsequently opted out of the project.

First, when the energy community was initially proposed within Avedøre Green City, the local housing association expressed interest in participating. However, they were later excluded from ECA due to regulatory barriers hindering public housing organizations from joining energy communities (refer to the subsection on handling conflict in the integrated case analysis). Interviews with bureaucratic actors in the project indicated that this barrier has been removed, hence the housing association has now been admitted to ECA.

Second, the involvement of local citizens in the project is limited, hindering their capacity for widespread influence. Although residents receive regular updates through their representatives in Avedøre Landsbylaug and can express their opinions in response, the ECA does not actively seek the input of individual citizens as an integral part of its decision-making processes. This limitation is partially attributed to organizational barriers, as the inclusion of individual citizens might be perceived as a potential complication to ECA's deliberative procedures. Consequently, while the project establishes institutional channels for local citizens to voice their opinions through their representatives, their role in the decision-making remains relatively insignificant.

Third, Avedøre Holme was, in principle, another prospective member of ECA insofar as they neighbor each other. However, they have not joined ECA as they have made parallel investments outside the organizational context of ECA. Informants have also noted that there is a cleavage in identity between Avedøre Holme and the existing members of ECA, as the former is an adjacent industrial area next to Avedøre that hosts more than 400 factories/businesses, hence their energy demands are different from commercial and residential areas. Most notably, industrial areas are characterized by energy-intensive processes due to production processes, resulting in divergent priorities in energy investments relative to commercial and residential areas.

Fourth, the facilitators of the ECA project acknowledge a deliberate decision not to expand the membership base in the current stage of its development. This choice is attributed to the existing barriers that hinder the project's scalability. However, there is an anticipation that additional members will be welcomed in the future, contingent upon the successful mitigation of significant barriers faced by energy

communities. This expansion is envisioned when the collaborative and membership aspects of the project can be feasibly scaled.

In discussions with various sources, we have identified several reasons why local businesses have opted not to participate in ECA. One crucial factor that influences businesses to join is the existence of a clear business case, ensuring that involvement significantly improves their financial performance. However, the extended time required for investments in solar panels introduces considerable uncertainty, causing businesses to hesitate in committing to such costly endeavors. This prolonged time frame is further complicated by the uncertainty surrounding the businesses' operational longevity over the next 10-15 years. Consequently, long-term investments are perceived as excessively risky, especially considering that a substantial number of local businesses operate from rented business premises. Investing in solar panels in a building they do not own does not provide a direct financial incentive for such endeavors, further diminishing their motivation to invest in the area's energy infrastructure.

A business consultant in Hvidovre Municipality suggested another potential reason for hesitancy in joining the ECA: the apprehension of shouldering future costs and responsibilities within this cooperative organizational model if it expands beyond the stakeholders' initial interests. Although the liability of co-owners is theoretically limited to their invested capital, safeguarding personal assets from covering cooperative debts and obligations, there's a latent fear that joining the ECA might lead to institutional pressures committing them to future investments against their interests. These perceived pressures mirror the concerns faced by residents regarding the current expansion of the local district heating system (Avedøre Fjernvarme), where individuals have reportedly felt pressured to join. The underlying reason for this latent pressure is that the district heating system's development depends on enough residential buildings choosing to participate. Consequently, advocates have been pushing for its adoption within the local community. A similar line of reasoning notably applies to the operational efficiency of energy communities, which realize their anticipated benefits when they reach a certain size, enabling them to tap into the efficiency gains of economies of scale.

In consequence, while significant steps have been taken to include several relevant and affected stakeholders, there are some latent barriers that inhibit the full collaborative potential within the entire district of Avedøre Energy Community.

12. Clarification of interdependence vis-à-vis common problem and joint vision

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

There is a consensus that the distributed ownership of the energy community has improved its success. First, ECA benefits from the economies of scale of pooling resources and a commitment to a shared procurement plan. As mentioned earlier, Filmbyen considered at an earlier stage to purchase solar panels independently but chose to join ECA as they reckoned that it would make it easier to navigate through the complex decision-making process of choosing suppliers and deciding where to place them.

Second, rallying behind an organization that shares a strategic outlook towards sustainable energy makes it possible to critically scrutinize investment decisions in solar panels and, in turn, ensure that they are properly coordinated. A major barrier to making such investments for large-scale institutional actors such as Filmbyen and Hvidovre Gymnasium is that to recover their investments, they are faced with long investment horizons. Several actors have reported that while they could have invested in solar panels independently, they recognize the value of joint participation in ECA. However, the example of Avedørelejren opting out of the ECA also reveals that not all relevant and/or affected actors necessarily recognize the value of entering a collaborative entity, which not only pools resources but also potentially distributes risks to all stakeholders.

Third, the cooperative ownership form also ensures mutual dependence among partners in relation to defining common problems and visions. All proposals for new installations and their implementation depend on the agreement of all partners. The success of the solutions relies on each participant putting forward their ideas and suggestions, exchanging knowledge and perspectives, and attempting to reach consensus through open discussion

Last, the local anchorage of the ownership structure affirms that all investors/stakeholders have 'skin in the game' and are committed to the energy community. For example, informants from Avedørelandsbylaug representing the local citizens argues that the local community is more positively disposed towards ECA because of its local anchorage, as they know that they make decisions that will support the local community. This dovetails with the prior point about the ECA not being a strictly profit-driven organization, for which reason it is perceived as more trustworthy as it is expected to weigh community interests alongside sustainability and returns on investments.

13. Trust-building and conflict mediation

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☒ High confidence	☒ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

Trust-building is a prerequisite for the success of ECA insofar as it involves long investment horizons to recover the costs of solar panels. As exemplified by the omitted participation of Avedørelejren, partaking in ECA involves a significant commitment in terms of organizational (technical, administrative, financial) resources that will span far into the future. The director of Filmbyen comments that partaking in ECA was a more complex process than anticipated, mentioning several challenges and barriers they have faced over the last two years. For example, he mentions that the diversity of participating stakeholders has different priorities (as they operate according to different institutional logics and rhythms) and thus does not act in unison. This leads to a greater need to coordinate and find compromises to ensure a smooth collaborative process. The overarching assumption is that, in case the project and its participating stakeholders are not perceived as credibly committed, the project was not likely to succeed.

The informants all reached the consensus that there is a high level of trust among the different participants, as there is a shared organizational vision about promoting green energy and to upscale the project. The project facilitators have also ensured that the collaborative process is as transparent as possible, hence there is a lower likelihood of misunderstandings. Consequently, there have been no reports of any major conflicts among the participating stakeholders. The representative of the local community (Avedørelandsbylaug) argues that the reason that they trust the project is partly due to its local ownership and anchorage, as local organizations and businesses are responsible for its operations. Rather than distant investors, local owners are perceived as more trustworthy.

Given that Hvidovre Municipality is one of the project's owners, some sources suggest that a slightly strained relationship occasionally exists. This tension arises from perceived issues such as a lack of responsiveness and bureaucratic delays hindering the progress of the energy community. Importantly, all informants assert that despite these latent tensions, collaboration has never been impeded. It is noteworthy that the strained relationship does not extend to the municipal worker operating within ECA; rather, it originates from the broader administrative system of the municipality, which has been observed to display a lack of responsiveness.

14. Use of experimental tools for innovation

QCA score:	Scoring confidence:	Data sources:
☒ 0	☒ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☒ Documents
☐ 0.66	☐ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

ECA does not rely on any experimental tools for innovation based on the strict definitions of user-centered design or prototyping. ECA has made a single small-scale investment described as a pilot project in the form of electric charging stations with solar rooftop panels. However, this appears so far to be an isolated investment, which was funded by Hvidovre Municipality as part of its “Pool for Green City” initiative. However, this has not translated into any follow-up programs that qualify as either prototyping or user-

centered designs. Currently, the two other investments have been solar panels placed on the premises of two of the key stakeholders, Hvidovre Gymnasium and Filmbyen.

15. Ongoing critical self-reflection and learning (i.e., process and/or developmental evaluation):

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☒ 0.33	☒ Medium confidence	☐ Documents
☐ 0.66	☐ High confidence	☐ Observations
☐ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

There are several significant evaluative measures to take stock of the progress in infrastructure investments, which are communicated during the board meetings. Furthermore, the organization is subject to all the legally mandated accounting requirements as a limited liability organization, such as reporting on its assets, liabilities, revenue, costs, and so on. However, these evaluative measures are not rigorous, meaning that there are no clear institutional mechanisms through which the feedback drawn from the evaluations are systematically leveraged to improve the project. During the two years during which the project has operated, informants have tentatively declared that no discernible feedback from these evaluative measures has substantively impacted the operations of the organization or the collaborative process. The reason for the relatively low significance of evaluative mechanism is due to the current scope of the project, which does not afford any substantial information to act upon through feedback mechanisms.

16. Exercise of facilitative leadership:

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Interviews
☐ 0.33	☐ Medium confidence	☐ Documents
☐ 0.66	☒ High confidence	☐ Observations
☒ 1		

Please elaborate on the reasoning behind your scoring for this governance factor:

All informants reported that the facilitative leadership of EBO Consult has been competent and laudable, especially because of their professionalism and efficient stakeholder management. For example, the project facilitators ensure that all relevant materials and information are disseminated in advance, thereby ensuring that all participants are properly informed about the project and, in turn, can make informed and sound judgments.

The importance of the project facilitators relates to their role as knowledge brokers, as the establishment of energy communities is a complex area that requires a lot of technical knowhows and competences, both in terms of the technological-engineering underpinnings of energy communities as well as the emergent

legal space through which ECA is navigating. As establishing an energy community was unprecedented prior to the inception of ECA, the participants ventured into a risky project that did not guarantee a clear pay-off, as it could risk failing or result in wasted resources. In their capacity as project facilitators, their ability to clearly communicate key information about the prospects of energy communities and their ability to instill confidence has been integral to the success of the project, in particular the collaborative processes between the multiple stakeholders who represented a diversity of interests. Consequently, the ability of EBO Consult to distill information that was both accessible and capable of guiding the stakeholders through this uncertain developmental path of ECA has resulted in a general trust towards their facilitative leadership. Competent leadership has also been prerequisite for trust-building, as the informants have noted that it has instilled greater confidence in their professional judgment.

Outcome variable: Successfully co-created green transitions

The outcome variable 'co-created green transitions' will be scored in two parts. First, 'co-creation' will be scored based on an assessment of whether the participants in the initiative, project or process engaged in collaborative problem-solving that fostered creative ideas and innovative solutions (data will consist of survey data combined with interviews and documents). Next, 'green transitions' will be scored based on an assessment of whether the initiative, project or process has fulfilled or is expected to fulfill its green goals, ambitions and aspirations (data will consist of survey data combined with interviews and internal and/or external evaluation reports, including scientific publications).

The scoring of this variable is done in two parts:

1. *Is the developed solution based on collaborative problem-solving spurring creativity and innovative solutions?*
2. *Does the developed solution engender a green transition?*

This scoring should be conducted based on both the survey and complementary green outcome evaluations. Please consult Sections 4.4 and 6.10 in the Research Protocol for more details.

1. Is the developed solution co-created?

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Survey
☐ 0.33	☒ Medium confidence	☒ Interviews
☐ 0.66	☐ High confidence	☐ Documents
☒ 1		☐ Observations

Please elaborate on the reasoning behind your scoring for this part of the governance factor, including the data sources used for the scoring.

The survey responses consistently demonstrate high scores across all items, with a mean score exceeding 2. This robust evidence suggests that the project has successfully fostered collaboration, nurtured creativity, and ultimately generated innovative solutions. A thorough examination of ECA further highlights the organization's distinctive social innovation features. Notably, ECA stands out as the pioneering energy community in Denmark, established in response to the EU Energy Directive introduced in 2018. This unique

organizational structure positions ECA at the forefront, venturing into uncharted legal and organizational territory. In navigating the complex and evolving landscape of sustainable energy, ECA has strategically embraced a probing approach, breaking new ground and adapting to the uncertainties of this domain.

The interview data consistently affirms the collaborative ethos within ECA, as all respondents attest to the organization's collective problem-solving approach, engaging in thoughtful deliberations on strategic decisions. In this collaborative framework, the facilitative leader plays a pivotal role, orchestrating the synergy among members. ECA's unique organizational structure, characterized by joint ownership and shared responsibilities, fosters a highly inclusive process, in stark contrast to more hierarchical organizations prone to forming informational silos and labor segregation. ECA's flat organizational design emphasizes horizontal relations, empowering members and redefining the facilitative leader's role to encompass initiation, convening, and facilitation of strategic decisions.

This inclusive approach has cultivated a high degree of trust among ECA members, fostering a willingness to collaborate and explore creative solutions that might be deemed risky in other contexts. Notably, joining ECA hasn't been without challenges, particularly considering the uncertainties surrounding the status of energy communities. Despite bureaucratic and legislative hurdles, the organization has adeptly navigated these obstacles, showcased resilience and successful collaboration while gradually scaling the energy community.

If possible, please insert your survey responses in the table below (in % for each response), including the mean/average % for each survey item.

N=7	Strong. dis.	Dis.	Slight. dis.	Neither agr/dis	Slight. agree	Agree	Strong. agree	Mean
1. Problem-solving mobilized different experiences, and/or ideas and/or forms of knowledge to develop new perspectives								2.57
2. Through the collaborative problem-solving process, different experiences and/or ideas and/or forms of knowledge have been mobilized to search for unconventional solutions						42.9%	57.1%	2.14
3. The collaborative problem-solving process mobilized different experiences, and/or ideas and/or forms of knowledge to search for solutions that go beyond standard/text-book solutions				14.3%		42.9%	42.9%	2.57
4. The co-created solution breaks with established practices						42.9%	57.1%	2.57

5. The co-created solution disrupts conventional wisdom						42.9%	57.1%	2.29
6. The co-created solution offers new ideas to address the green transition problem					14.3%	42.9%	42.9%	2.57
7. I'm supportive of the co-created solution					14.3%	14.3%	71.4%	2.71
8. I'm content with the overall collaborative process of the project						28.6%	71.4%	2.43
9. I feel the multi-actor collaboration process was a prerequisite for the success of the project						57.1%	42.9%	2.43
10. I'm satisfied by the results of the co-creation effort in terms of expected impact on the welfare of the community				14.3%		14.3%	71.4%	2.43
11. The collaborative interaction in the project has led to an innovative solution						57.1%	42.9%	2.57
12. The actors involved in the project are engaged in collaborative interaction that stimulated creative problem-solving						42.9%	57.1%	2.14
13. The co-created solution meets the proposed goals of the project					14.3%	57.1%	28.6%	2.14
14. The co-created solution will be durable and robust in the long run					28.6%	28.6%	42.9%	2.43
15. The co-created solution is expected to significantly improve sustainability for the whole community						57.1%	42.9%	2.57

2. Does the developed solution engender a green transition[1]?

QCA score:	Scoring confidence:	Data sources:
☐ 0	☐ Low confidence	☒ Survey
☐ 0.33	☒ Medium confidence	☒ Interviews
☒ 0.66	☐ High confidence	☒ Documents
☐ 1		☐ Observations

Please elaborate on the reasoning behind your scoring for this part of the governance factor, including the data sources used for the scoring:

The green output/outcome of ECA is twofold: (1) the initial rounds of investments into renewable energy infrastructure in the form of solar panels and electric charging stations since the establishment of the organization in 2020, and (2) the organization as a legal entity and organizational model that operates as a relatively self-organizing network of cross-sectoral stakeholders that optimizes the local production, distribution, and consumption of electricity.

The green outcome in terms of the initial round of investments into renewable energy infrastructure has been:

a) 11kWp solar panels and accompanied by four 22kW charging stations
b) 101 kWp solar panels at Hvidovre Gymnasium
c) 152.52 kWp solar panels at Filmbyen
d) 8x 24 kW electric charging stations
e) 0.5 MW battery connected to the local data center that will, once fully implemented, manage the data aggregation, grid management, facilitate peer-to-peer energy transactions, energy asset management, and demand and response optimization

Further investments are expected to occur in the next several years, insofar as Avedøre is an old city district. As the local energy infrastructure and buildings are old, it will benefit substantially from the gradual expansion of renewable energy infrastructure, such as solar power and the electrification of the district heating system in collaboration with Avedøre Fjernvarme, which are expected to yield high savings in energy costs. Plans have also been declared to install solar panels on the local residential blocks as an integrated energy source for the heat pumps in the district heating system, although this ambition has not been realized yet as it will unfold alongside the expansion of the district heating system by Avedøre Fjernvarme. Avedøre is slated to implement its district heating system by 2024-2025.

The green outcomes in terms of the ECA as a local network of energy-optimizing production, distribution, and consumption of electricity. However, insofar as the energy community does not share energy between land parcels and different stakeholders, it has not been able to realize its full energy- and cost-optimizing potential. The energy community does not currently improve on the parallel mechanisms in the status quo whereby private and public sector actors purchase and install their own solar panels and electric charging

[1] By ”green transitions”, we mean objectives and aspirations that correspond to at least one of the Green SDGs (SDG 6, 7, 11, 12, 13, 14, 15). The project does not have to refer explicitly to the green SDGs, but the project’s green objectives

stations. After all, Filmbyen noted initially that they wanted to purchase solar panels regardless. The current organizational advantage of ECA is the fact that it provides a collaborative platform and venue for a diversity of actors to pool resources together to procure solar panels. However, these benefits relating to pooling resources are not exclusive to the organizational model of energy communities, as a shared procurement plan can be made through other purchasing agreements.

As of December 2023, ECA has initiated energy sharing, albeit on a relatively modest scale, resulting in limited gains in energy enhancement. The respondents all unanimously agree that ECA yields a green transition solution that improves upon the status quo. However, considering the organization's incomplete realization of its full ambition and potential, it currently scores 0.66, reflecting only partial achievement of its own goals in terms of the scale of energy sharing and sectoral coupling. There is optimism for a future score of 1 in the coming years, contingent upon overcoming the existing barriers that have impeded the organization's progress.

If possible, please insert your survey responses in the table below (in % for each response).

1. The project:	**Distribution**
…did not produce any green transition solution	
…is expected to produce/has produced a green transition solution aiming to avoid a worsening in the status quo	
…is expected to produce/has produced a green transition solution aiming to maintain the status quo	
…is expected to produce/has produced a green transition solution aiming to improve the status quo	100% (7)

Please list all the informants you have interviewed for the case study (list project role + interview date):

Actor	Description/role
Project facilitator from EBO Consult (interviewed twice)	The facilitative leader organizing all the meetings and advising ECA on strategic decisions and planning
Local politician from Hvidovre Municipality	Sits on the board of ECA
Local politician from Hvidovre Municipality	Sits on the board of ECA and Avedøre Fjernvarme
Local politician from Hvidovre Municipality	Sits on the board of Avedøre Fjernvarme
The CEO of Filmbyen	One of the core actors sitting at the board of ECA
The rector of Hvidovre Gymnasium	One of the core actors sitting at the board of ECA
A representative from Avedøre Landsbylaug	One of the core actors sitting at the board of ECA
A representative from Avedøre Fjernvarme	One of the core actors sitting at the board of ECA
A bureaucratic actor from Hvidovre Municipality	Key consultant supporting ECA, providing technical support in the permissibility of specific project initiatives
A bureaucratic actor from Hvidovre Municipality	Business consultant that has been involved in Avedøre Green City facilitating business partnerships with the municipality

Please list all the observations you have made (type of meeting/workshop/etc. + observation date):

We have attended two workshops (26/10/23 and 25/01/24) organized by the umbrella organization, Energifællesskaber Danmark (Energy Communities Denmark) in which EBO Consult is a member. The workshops discuss the purpose of energy communities and the current landscape of opportunities/barriers that shape their viability.

One on-site visit of Avedøre Landsby (village) to receive an introduction of the local community and the layout of the residential area. The representative of Avedøre Landsbylaug guided the tour, which was followed by an interview.

Please list all the documents you have analyzed (document name + source + year):

EBO Consult (2020) Danmarks Første Energifælleskab

EBO Consult (n.d.) Energifællesskaber

Hvidovre Kommune (n.d.) Klimaplan 2045

Intelligent Energi (2021) Borgerenergifællesskaber: Den nye elev i klassen

Danske Kommuner (2022) El og varme skal flyde frit i Avedøre

Rådet for Grøn Omstilling (2023) Fra revolutionerende filmdogmer til banebrydende lokalt energifællesskab

Radius (n.d.) Energifællesskaber: En del af den grønne omstilling

Energifællesskaber Danmark (2023) Håndbog for Energifællesskaber

Energifællesskaber Danmark (2023) Hvad er et energifællesskab?

Energifællesskaber Danmark (2023) Case-Samling 2023

Jensen m.fl. (2023) Sektorkobling via Energifællesskaber: Værdi-Sensitivt Design i Energifællesskab Avedøre

European Investment Bank (2021) ELENA Project Factsheet Avedore Green City (AGC)

Avedøre Green City (2021) Ladestandere under strømproducerende tag i Avedøre Green City klar til brug

Please note the response rate for the survey/measurement of outcome variable:

The survey received 7 responses out of 9 relevant respondents, which are working directly with ECA.