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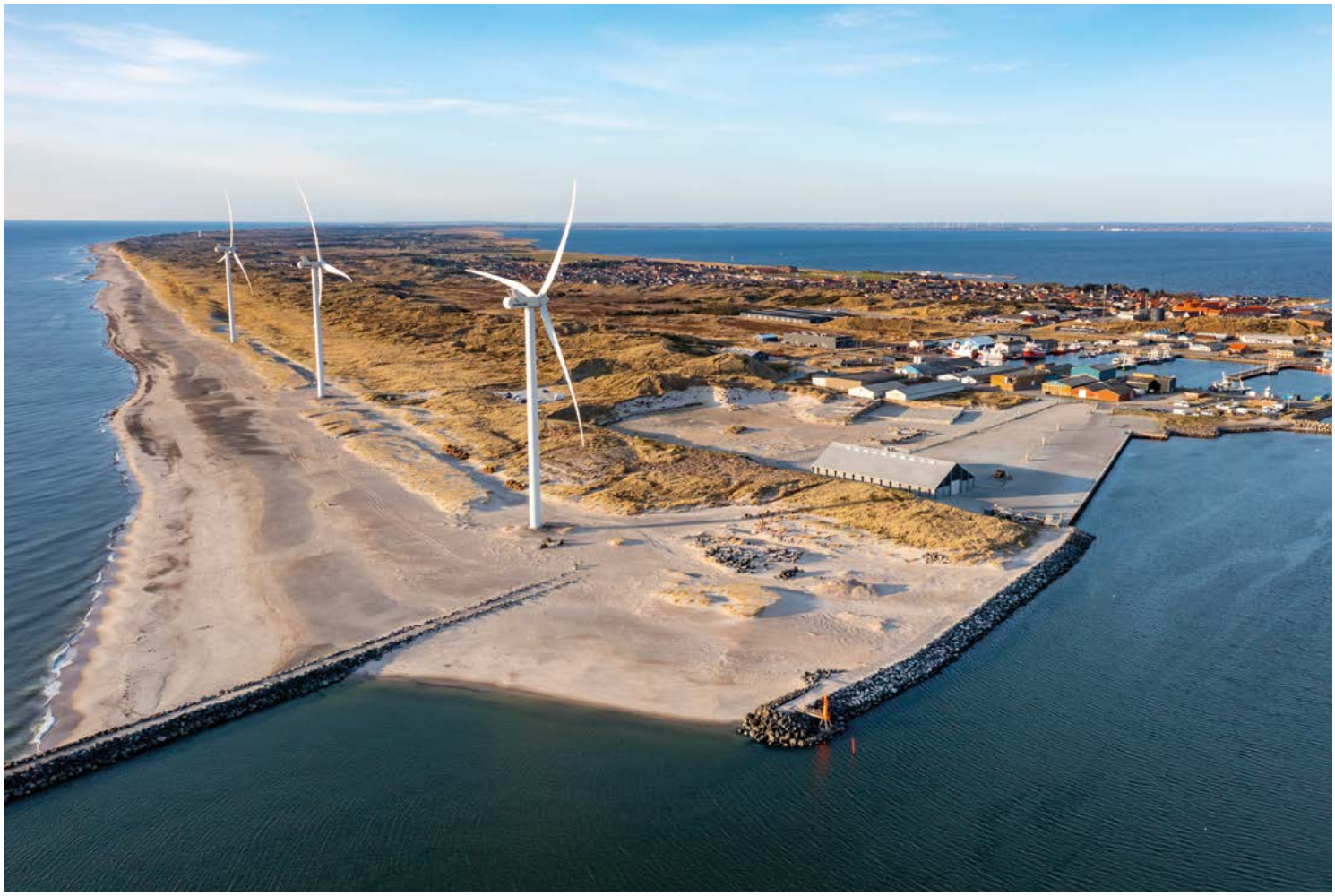

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Implementing EU-defined energy communities in the Nordics.

The role of path dependencies in shaping divergent outcomes

The Nordic countries have well-established community energy traditions. However, the extent to which these traditions align with the European Union's definition of energy communities varies from country to country.

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Implementing EU-defined energy communities in the Nordics. The role of path dependencies in shaping divergent outcomes
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Abstract
The EU's *Clean Energy Package* introduced renewable and citizen energy communities (RECs/CECs) to strengthen citizen participation in electricity markets. Nordic countries, however, have long-standing traditions of community-based energy provision, including district heating cooperatives, small hydropower schemes, and wind cooperatives. This article examines how nationally embedded energy models in Denmark, Finland, Norway, and Sweden align with or diverge from the legal and governance criteria defined in the *Renewable Energy Directive* RED II and the *Internal Electricity Market Directive* IEMD. Using a comparative institutional framework, the study analyses regulatory design, ownership structures, and system configurations shaping implementation. The findings show that regulatory conditions, rather than cooperative traditions alone, determine alignment. Finland demonstrates high compatibility, Denmark and Sweden partial alignment, and Norway limited alignment, being outside the EU framework. The study highlights how institutional path dependencies condition the practical realisation of EU energy community provisions.

Keywords
citizen energy communities, energy markets, EU Clean Energy Package, Nordic countries, renewable energy communities, renewables

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The EU's *Clean Energy Package (CEP)* introduced renewable energy communities (RECs) and citizen energy communities (CECs) as legal instruments intended to foster active citizen participation in electricity markets and to democratise the energy transition. Through the *Renewable Energy Directive (RED II)* (Directive [EU] 2018/2001) and the *Internal Electricity Market Directive (IEMD)* (Directive [EU] 2019/944), EU citizens are granted rights to act as active participants in the energy system, including generating, consuming, storing, and selling electricity individually or collectively, notably through the frameworks of renewables self-consumers, active customers, and energy communities, subject to national implementation and in accordance with the applicable national law. These provisions reflect a broader policy ambition to combine decarbonisation with social inclusion and local value creation (Neij et al. 2025, Berka and Creamer 2018).

The Nordic countries, Denmark (DK), Norway (N), Finland (SF), and Sweden (S), offer a compelling analytical context for studying the evolution of energy communities (ECs). The region is distinguished by high institutional trust, deep-rooted traditions of cooperative ownership, robust municipal autonomy, and a highly integrated cross-border electricity market through Nord Pool[1] (Porte et al. 2023). Collective and community-based energy initiatives, such as district heating cooperatives, small hydropower schemes, and wind cooperatives, have thrived here for decades (Bauwens et al. 2016, Neij et al. 2025).

At first glance, these institutional features seem to create fertile ground for the adoption of EU-defined ECs. However, the degree to which historically embedded Nordic models align with the EU's RECs and CECs remains uncertain.

Existing research demonstrates that the development of community energy is strongly shaped by national market design, regulatory stability, and cooperative traditions (Bauwens et al. 2016, Mignon and Rüdinger 2016, Blasch et al. 2021, Neij et al. 2025). Comparative studies have emphasised that institutional contexts >

1 The Nord Pool is the world's first multinational power exchange and remains a key platform for cross-border electricity trading across Denmark, Norway, Sweden, Finland, Estonia, Latvia, and Lithuania.

condition the viability of citizen-led renewable energy initiatives and influence their organisational forms (Sokolowski 2020, Petrovics et al. 2024). However, there remains limited empirical work examining how long-standing national energy models relate specifically to the legal architecture introduced by *RED II* and *IEMD,* leaving the effects of the existence of different institutional frameworks on the European energy transition unclear.

While the *Clean Energy Package* establishes common legal categories, their implementation depends on national regulatory frameworks and historically embedded system configurations, raising questions about how uniformly EU energy policy is realised in practice. Focusing on the Nordic region, this article examines how established community-oriented energy arrangements interact with, adapt to, or diverge from EU-defined EC provisions. Specifically, it addresses the following research question:

> *To what extent do existing Nordic energy community models – reflected in nationally embedded examples – align with or diverge from the core legal, organizational, and participatory features of EU-defined RECs and CECs, and how do national regulatory and system configurations shape this alignment and the implementation of EU energy community provisions?*

The study contributes to the literature in three ways. First, it offers a systematic comparison of Nordic EC models with EU REC and CEC criteria, clarifying their degree of compatibility. Second, it advances understanding of how national conditions shape the implementation of EU provisions (Magni et al. 2024). Third, it refines comparative research by moving beyond descriptive case studies toward an explicitly institutional analysis of alignment and divergence.

EU regulatory framework for energy communities

The *CEP* establishes two legal categories: RECs under *RED II* (Directive [EU] 2018/2001) and CECs under *IEMD* (Directive [EU] 2019/944). Both are defined as legal entities based on open and voluntary participation, effective member control, and a primary purpose of delivering environmental, social, or community benefits rather than profit. RECs are restricted to renewable energy activities and require proximity between members and projects. Member States must provide enabling frameworks, including access to markets and the possibility of collective self-consumption and energy sharing, subject to national conditions. CECs have a broader scope, may engage in energy generation, supply, distribution, storage, and aggregation, as well as energy services, and are not limited to renewables or proximity. However, Member States retain discretion regarding governance conditions, tariff design, grid access, and the extent of operational rights. While the directives establish common legal principles, their practical implementation depends on national regulatory design, market structure, and existing infrastructural arrangements (Palm 2021, Frieden et al. 2021).

Analytical framework: Institutional shaping of energy communities

ECs are not merely technical arrangements but institutional configurations combining legal recognition, governance structures, ownership models, and socio-technical infrastructures (Bauwens et al. 2016, Mignon and Rüdinger 2016). In the EU context, these configurations are expected to align with the legal and governance principles defined for REC and CEC. However, such alignment is not automatic. Regulatory design shapes how EU provisions are operationalised in national contexts, including rules on collective self-consumption, grid access, and market participation. Ownership and governance models may be normatively compatible with EU principles such as member control and community benefit, yet still diverge in practice due to national legal traditions and organisational forms. In addition, system configurations and path dependencies, including concession regimes, tariff structures, grid regulation, or infrastructural constraints, can hinder implementation even where EU directives have been formally transposed and legal rights to energy sharing exist.

Addressing such mismatches between EU-level provisions and their practical realisation is central for achieving EU policy objectives, as uneven implementation may limit the effectiveness and comparability of energy community development across Member States.

This study therefore analyses the alignment of national energy community models with EU-defined REC and CEC frameworks across three dimensions:

Regulatory design refers to how national frameworks operationalise EU provisions for RECs and CECs, including rules for collective self-consumption, energy sharing, tariff structures, taxation, grid access, and formal recognition (Inês et al. 2020, Blasch et al. 2021).

Ownership and governance of ECs refer to the internal organizational and decision-making arrangements of ECs, including legal forms (e.g., cooperatives), member control mechanisms, and benefit-sharing models. This dimension focuses on how communities are structured and governed independently of external regulatory frameworks (covered in dimension 1) (Sokolowski 2020, Palm et al. 2025).

System configuration and path dependencies capture how concession regimes, grid structures, and historically embedded energy systems enable or constrain EC activity, regardless of formal legal status (Moreno et al. 2025).

On this basis, three propositions guide the analysis:

1. The alignment of national EC models with EU-defined RECs and CECs is primarily shaped by regulatory design, rather than by cooperative traditions alone.
2. Historical governance models may be normatively compatible with EU-defined REC and CEC principles yet diverge in prac-

tice where communities lack effective control over infrastructure or access to electricity markets, which are key conditions for operationalising EU provisions.

3. Infrastructural and regulatory path dependencies limit operational scope even where EU directives are transposed.

The focus is institutional alignment with EU-defined legal and governance features, not technological performance.

Methodology

This study uses a comparative qualitative case study design to examine how nationally embedded EC models in DK, N, S, and SF align with EU-defined RECs and CECs, integrating legal review with institutional analysis.

National implementation of *RED II* and *IEMD* was analyzed through legislative documents, policy reports, and academic literature, with a focus on collective self-consumption rights, energy sharing, tariff and taxation rules, grid access, and formal EC recognition. N was included to provide a comparative Nordic perspective outside the EU. Cases were selected as typical institutional expressions of community-oriented energy models in each country, reflecting dominant organizational forms shaped by national regulatory and infrastructural contexts. Selection criteria included institutional relevance, analytical significance for REC/CEC alignment, and documented governance characteristics. In DK, district heating cooperatives were chosen, supplying over 60 % of households with more than 60 % renewable energy and operating largely under consumer ownership (Johansen and Werner 2022, DBDH 2025). In N, small hydropower schemes were selected as the closest institutional analogue to REC-type initiatives, embedded in concession-based local ownership (Gustad 2018, Rygg et al. 2021). In SF, cases were drawn from legally recognized EC models introduced after the *Government Decree on the Settlement and Metering of Electricity Supplies* (Ministry of Economic Affairs and Employment 2021), including housing-company photovoltaics(PV) and the Lumituuli wind cooperative (Kortetmäki et al. 2024). In S, PV cooperatives were selected, representing the primary citizen-led renewable energy model, given the lack of a formal REC category.

The study pursues analytical rather than statistical generalization, treating cases as institutional configurations that reveal how regulatory design, governance structures, and infrastructural path dependencies shape compatibility with EU REC/CEC definitions (Blasch et al. 2021). The objective is to identify structural conditions for alignment, not to measure diffusion or performance.

Results and discussion

The following section assesses the alignment of national EC models with EU RECs/CECs across three dimensions: 1. *regulatory design* (national transpositions and market rules), 2. *ownership and governance of ECs* (legal forms and member control), and 3. *system configuration* (grid access, tariffs, and path dependencies). Country-specific synopses are given in tables 1 to 4.

Denmark

Regulatory design

DK formally transposed CEP elements via 2023 amendments to the *Electricity Supply Act* (Folketinget 2023), defining CECs and enabling internal distribution of self-produced electricity. However, the framework remains restrictive: electricity must generally be consumed "behind the meter," limiting collective self-consumption to the same or adjacent properties (Sorknæs et al. 2022, Inês et al. 2020). District heating, governed separately, requires consumer ownership and non-profit operation, institutionalizing collective ownership without formal REC/CEC classification (Johansen and Werner 2022).

Ownership and governance

DK's renewable energy sector has historically relied on strong cooperative traditions, especially in wind power (Petersen 2018, Gorroño-Albizu et al. 2019). While commercial actors now dominate ownership (Borch et al. 2020, 2023), cooperative governance persists in district heating. Two cases illustrate this model: Hvide Sande District Heating, a consumer-owned company integrating wind power to meet nearly all demand renewably (Gorroño-Albizu et al. 2019), and Spjald District Heating, locally owned and operating a biogas heat and power system combined with solar >

TABLE 1: National example: Denmark.

CASE	CITIZEN ENGAGEMENT	TYPE OF RENEWABLE ENERGY	SCALE
Hvide Sande District Heating *https://hsfv.dk* (figure 1, p. 102)	consumer owned, non-profit	97 % renewable production of district heat (DH), from wind turbines, photovoltaics, and solar heat combined with heat pumps and electric boilers. Excess production of electricity is sold via Nord Pool.	Supply of 1,650 local households with DH. 61 GWh distributed in total (50 % heating, 50 % electricity).
Spjald District Heating *https://spjald-fjv.dk*	consumer owned, non-profit	Combined heat and power driven by biogas (80 %) supplemented with solar heat (18–20 %). Excess production of electricity is sold via Nord Pool.	Supply of approximately 1,000 heat consumers in Spjald and the surrounding area with DH, including households, businesses, and public buildings.

FIGURE 1: The wind turbines at Hvide Sande, Denmark. Effect: 3 x 3 MW. Height: 140 meters.

thermal energy. Both prioritize democratic governance and local benefit, aligning normatively with REC criteria (Sokolowski 2020).

System configuration and path dependency

Despite strong cooperative ownership, DK's electricity distribution remains distribution system operator (DSO)-controlled within a concession regime. Property-bound rules and tariff structures constrain energy sharing beyond individual parcels. Hvide Sande's acquisition of a narrow strip of land to legally connect installations without using the public grid illustrates how regulatory interpretation shapes feasible organisational forms (Sorknæs et al. 2022). These constraints reflect broader findings that regulatory design and infrastructural arrangements strongly condition community energy development (Mignon and Rüdinger 2016, Moreno et al. 2025). While sector coupling between wind energy and district heating is institutionally mature, electricity-based collective self-consumption remains limited.

These constraints reflect path-dependencies in the Danish energy system, including the historical development of district heating cooperatives and property-based regulatory rules, which continue to shape the scope for collective electricity sharing.

National alignment assessment

DK demonstrates high normative compatibility with REC/CEC governance principles through established cooperative and consumer-owned energy models. However, regulatory design restricts collective electricity sharing and limits the operationalisation of REC provisions. In line with comparative research emphasising the centrality of enabling frameworks (Blasch et al. 2021, Inês et al. 2020), Denmark's alignment is best characterised as partial: cooperative ownership is well developed, but electricity market regulation constrains the full implementation of EU-defined EC provisions.

Norway

Regulatory design

Norway, not an EU member but integrated into the EU energy market via the *EEA Agreement* and *Green Alliance* (Regjeringen 2024a), has not transposed REC or CEC provisions. Renewable projects are governed by concession-based procedures under the *Norwegian Water Resources and Energy Directorate* (Gustad 2018). Only certified operators may manage grids, and no REC/CEC equivalent exists. Recent proposals allow limited (≤ 5 MW) surplus electricity sharing in industrial areas (Regjeringen 2024b), but these do not create a general framework for citizen-led collective self-consumption as required by the EU.

Ownership and governance

Small hydropower schemes are Norway's closest analogue to EU-defined ECs, requiring ≥ 50% local landowner ownership (Gustad 2018). The Vika Kraftverk case exemplifies this: a group of local farmers co-own the installation, but participation is restricted to water rights holders, not open or voluntary as per REC criteria (Sokolowski 2020). Neighbours without rights receive no direct benefits, relying on municipal tax revenues. Social acceptance studies also highlight disputes over local benefit distribution (Rygg et al. 2021).

System configuration and path dependency

N's electricity system is dominated by large-scale hydropower within a concession regime that centralises approval and limits distributed electricity sharing (Gustad 2018). Grid operation is tightly regulated, and collective self-consumption rights comparable to those defined in *RED II* are not legally recognised. Un-

TABLE 2: National example: Norway.

CASE	CITIZEN ENGAGEMENT	TYPE OF RENEWABLE ENERGY	SCALE
Vika Kraftverk, Kvinnherad municipality (figure 2)	Co-owned by five farmers with exploitation rights to the river. Neighbours who are not river-rights holders typically receive no direct economic benefits, relying instead on indirect municipal revenues or voluntary arrangements.	Hydropower sold via Nord Pool.	4.1 MW turbine delivering 14 GWh a year, which is sold directly to the grid.

FIGURE 2: Inlet to the small hydro power plant Åkra in Kvinnherad, Norway. Owner Vika AS. Effect: 4.1 MW. Fall height: 401 meters.

FIGURE 3: 2 MW wind turbine in Lumijoki, Finland, owned by Lumituuli Oy, Finlands first and largest consumer-owned wind power company.

like DK or SF, N lacks a strong institutional tradition of distributed renewable energy cooperatives in electricity generation. This socio-technical configuration restricts the feasible scope of REC-type initiatives and reinforces centralised governance structures.

These constraints reflect path dependencies in the Norwegian energy system, notably the historical dominance of large-scale hydropower and concession-based governance, which continue to favour centralised control and limit the development of decentralised, community-based energy models.

National alignment assessment

N displays low alignment with EU REC/CEC definitions. Although small hydropower schemes incorporate elements of local ownership, governance is not open, participation is restricted, and collective self-consumption rights are absent. Regulatory design and concession-based system configuration jointly constrain the emergence of EU-style ECs. Substantial legal and institutional reform would be required to achieve alignment.

Finland

Regulatory design

Finland has legally recognized ECs in its electricity market regulation (Ministry of Economic Affairs and Employment 2021). Since 2023, DSOs must offer virtual net metering, enabling collective self-consumption within defined EC structures (Kortetmäki et al. 2024). Three models – on-site, adjacent property, and dispersed communities – are recognized, though current legislation restricts ECs to same-building multi-tenancy arrangements, excluding wider neighbourhoods. Shared electricity may be exempt from certain fees, while grid-sourced power incurs standard charges. Finland's framework is the clearest in the Nordics, aligning closely with *RED II*.

Ownership and governance

Finland's housing company model is central to collective energy initiatives. For example, the Pori housing association installed PV panels post-reform, using virtual net metering to distribute surplus electricity (Kortetmäki et al. 2024). Governance leverages existing housing association structures, ensuring member participation. Lumituuli Oy, a citizen-owned wind cooperative with 1,200+ shareholders, reinvests profits into renewables, aligning with REC principles (Sokolowski 2020). However, Finland's wind energy sector is increasingly dominated by large, foreign-owned actors (Pelastetaan Suomen Luonto ry 2024).

System configuration and path dependency

SF's liberalised electricity market and mandatory virtual net metering reduce infrastructural barriers to collective self-consump- >

TABLE 3: National example: Finland.

CASE	CITIZEN ENGAGEMENT	TYPE OF RENEWABLE ENERGY	SCALE
Housing company in Pori	Building owners' initiative in a local housing company.	Photovoltaics (PV) panels supplying first the buildings. Excess production of electricity is sold via Nord Pool.	36 PV panels, 15 kW power.
Lumituuli Oy *https://lumituuli.fi/voimalat* (figure 3)	Citizen-owned, founded in 1998. The organization uses its profits to make new wind power investments in SF.	Wind power supplied to cooperative members/owners.	8 GWh delivered to 1,200+ members in 2023.

FIGURE 4: PV park Solar Park in Helsingborg, Sweden.

tion (Kortetmäki et al. 2024). However, diffusion remains moderate. Earlier research indicates that regulatory alignment alone does not guarantee rapid scaling, as actor incentives and market structures also influence uptake (Gui and MacGill 2018, Blasch et al 2021). Lumituuli was the early mover of community wind power and became an embedded model. However, today the market is dominated by for-profit developers and major utility companies.

These arrangements reflect path dependencies in the Finnish energy system, particularly the institutionalisation of the housing company model and recent metering reforms, which enable collective self-consumption but also delimit it to specific organisational forms.

National alignment assessment

SF displays high alignment with EU REC/CEC definitions. Regulatory design operationalises key collective self-consumption rights, and ownership models are compatible with EU governance criteria. Nonetheless, market concentration and moderate diffusion illustrate that enabling legislation is necessary but not sufficient for widespread EC expansion (Inês et al. 2020, Petrovics et al. 2024).

Sweden

Regulatory design

Sweden lacks a distinct legal category for RECs or CECs. Despite a 2020 proposal by the Energy Market Inspectorate to align with EU definitions, the government deemed existing legal forms sufficient (Palm 2021). Amendments to the regulation governing non-licensed (exempt) electricity networks introduced provisions enabling limited energy sharing within microgrids (Sveriges Riksdag 2007), but dual connection requirements, taxation, and network fees undermine the economic viability of collective self-consumption (Palm 2021, Envall et al. 2023). Sweden's electricity market remains highly unbundled, with ~ 170 DSOs operating under concession regimes.

Ownership and governance

Two solar ECs illustrate contrasting approaches: Solel i Näversjön, a citizen-initiated cooperative governed democratically, and Solel i Helsingborg, launched by a municipal utility, highlighting the dominance of municipally owned utilities (Palm et al. 2025). Both adopt cooperative governance models formally aligned with REC criteria (Sokolowski 2020), though their primary function – selling electricity to the grid rather than collective self-consumption – limits functional alignment with EU-defined RECs.

System configuration and path dependency

S's concession-based grid structure and strict unbundling rules constrain community control over distribution infrastructure (Palm 2021). Microgrid arrangements require dual connections, and tariff structures weaken incentives for collective self-consumption (Envall et al. 2023). These socio-technical configurations illustrate how infrastructural design shapes EC feasibility (Moreno et al. 2025).

These arrangements reflect path dependencies in the Swedish electricity system, including early market liberalisation, strong unbundling requirements, and the historical role of municipally owned utilities, which continue to constrain community control over infrastructure and electricity sharing.

TABLE 4: National example: Sweden.

CASE	CITIZEN ENGAGEMENT	TYPE OF RENEWABLE ENERGY	SCALE
Solel, Näversjön	Citizen initiative with only local investments. 96 shares. One share costs 1,850 EUR. Not open for new members.	Photovoltaic panels. Electricity sold via Nord Pool.	Estimated 80–90,000 kWh per year sold to the grid.
Solar Park, Helsingborg *https://solarpark.se* (figure 4)	Initiated by the municipality-owned energy utility, which later invited the citizens to join. One share costs 300 EUR.	Photovoltaic panel. Electricity sold via Nord Pool.	1,3 GWh sold to the grid 2023. 763 members (2025).

TABLE 5: Explicit comparison of alignment of EC regulations with EU models regarding regulatory design, ownership and governance of ECs, as well as system configuration and path dependency between the four Nordic countries.

COUNTRY	DEGREE OF ALIGNMENT OF EC REGULATIONS WITH EU MODELS		
	REGULATORY DESIGN	OWNERSHIP/GOVERNANCE	SYSTEM CONFIGURATION
Denmark	***Medium:*** REC/CEC framework partly implemented; market rules (tariffs, grid fees) misaligned.	***High:*** Cooperative tradition aligns well; municipal and professional developers dominance reduces autonomy.	***Low:*** Dominance of distribution system operators (DSOs), high grid tariffs, and legacy systems limit implementation.
Norway	***Low:*** Slow transition; market rules favour hydropower and industry, not local sharing.	***Low:*** Municipal/state/utility dominance; limited citizen-led initiatives.	***Low:*** Centralized grid, hydropower focus, and tariffs discourage community projects.
Finland	***Medium:*** Legal recognition exists; the regulation covers only basic EC forms.	***Medium:*** Cooperatives align with EU principles; municipal energy companies dominate.	***Low:*** Cooperatives align with EU principles; municipal energy companies dominate.
Sweden	***Low:*** Absence of formal REC/CEC framework; limited microgrid provisions under IKN taxation, and network fees constrain collective self-consumption.	***Medium:*** Cooperatives align well; municipal energy companies limit autonomy.	***Low:*** Concession regimes and DSO dominance restrict grid access for communities.

National alignment assessment

S demonstrates normative compatibility in governance structures but limited operational alignment. Regulatory design and infrastructural constraints hinder the practical realisation of collective self-consumption and autonomous community operation. Consistent with comparative research (Taromboli et al. 2024), electricity market rules ultimately determine whether EU-defined EC provisions can be effectively realised in practice.

Conclusion

This study has explicitly compared the alignment of national EC models with EU-defined EC frameworks across three dimensions (table 5): 1. regulatory design, 2. ownership and governance, 3. system configuration and path dependency. The Nordic countries display differentiated alignment with EU-defined RECs and CECs (table 6, p. 106). Finland shows high compatibility due to explicit legal recognition and virtual net metering. Denmark and Sweden demonstrate partial alignment: cooperative traditions are strong, yet regulatory and infrastructural constraints limit energy sharing. Norway remains outside the EU framework and exhibits low alignment. The analysis confirms that historically embedded institutional arrangements only partially align with EU legal architecture. While cooperative ownership and local participation are widespread, collective self-consumption rights, grid access, and tariff structures vary significantly across countries.

Proposition 1 is strongly supported: regulatory design explains cross-national variation more convincingly than cooperative traditions alone. DK and S, despite strong cooperative models, face operational misalignment due to restrictive sharing rules and grid governance, whereas SF's clearer framework yields higher compatibility.

Proposition 2 is partially confirmed: Nordic governance traditions normatively align with EU principles of member control and community benefit, but practical rights to energy sharing and infrastructure control remain limited. N's small hydropower schemes exemplify local ownership without open participation or collective self-consumption.

Proposition 3 is strongly confirmed: concession regimes, DSO dominance, tariff design, and system configurations significantly constrain EC implementation. Even in SF, where legal transposition has occurred, diffusion depends on market incentives and actor engagement.

EU EC definitions prioritise autonomy, proximity, and participatory control, while Nordic energy systems are characterised by varying combinations of cooperative traditions, municipal ownership, and concession-based governance. Although these features are present across the Nordic countries, they are institutionalised differently, leading to distinct configurations rather than a single "Nordic model". Alignment should therefore be understood as a question of institutional compatibility between EU-defined frameworks and nationally embedded arrangements, rather than normative superiority. The observed differences in alignment are not merely descriptive. They indicate how effectively EU energy community provisions can be realised in practice. Higher alignment, as in Finland, is associated with clearer regulatory pathways for collective self-consumption and energy sharing, whereas partial or low alignment, as in Denmark and Sweden, reflects regulatory and infrastructural barriers that limit the operational scope of ECs despite strong cooperative traditions. In Norway, the absence of a corresponding framework constrains the emergence of EU-style ECs altogether. These differences suggest that regulatory design and system configuration influence not only institutional compatibility but also the scope >

TABLE 6: Summary of overall Nordic energy community (EC) alignment with EU REC/CEC definitions and key institutional drivers/obstacles.

COUNTRY	OVERALL ALIGNMENT WITH REC/CEC (EC) DEFINITIONS	MAIN ENABLING/CONSTRAINING INSTITUTIONAL FACTORS	IMPLICATIONS FOR EU POLICY IMPLEMENTATION
Denmark	***Partial:*** Strong cooperative history, but energy sharing constrained by property bound rules.	Long-standing citizen ownership in district heat and wind energy; restrictive distribution rules; distribution system operators (DSOs) dominate the grid. Weak incentives for ECs.	Normative compatibility exists, but regulatory barriers prevent full alignment with EC models.
Norway	***Low:*** Not implementing EC; small hydropower cooperatives share some traits but lack legal status.	Centralised approval of renewable energy projects; concession-based governance; limited legal pathways for community energy sharing (industrial).	ECs remain outside national legislation; alignment unlikely without structural regulatory reform.
Finland	***High:*** Clear legal categories, virtual net metering, tariff exemptions enable EC formation. However, forming CEC/REC across a neighbourhood or larger area is not allowed.	Supportive regulation; transparent market rules; established cooperative traditions; limited DSO incentives.	Framework largely compatible with EU-definitions, but alignment moderate due to low public awareness and cautious DSO engagement.
Sweden	***Partial-low:*** Microgrid rules permit limited sharing; dual connection requirements constrain EC autonomy.	Unbundled market design; strong municipality utilities; complex network regulations; weak economic incentives for ECs.	EC development restricted to small PV cooperatives; EU-aligned rights difficult to operationalise under current rules.

and pace of EC development within the broader energy transition. This implies that differences in institutional alignment may translate into uneven contributions of ECs to the energy transition across countries.

Implications for EU implementation: While EU regulation is necessary, it is not sufficient. Clear and coherent frameworks improve alignment, but formal transposition of regulations alone does not guarantee operationalization. Regulatory flexibility must address path dependencies in tariffs, grid governance, and market structures; otherwise, EU EC provisions risk remaining symbolic.

In summary, regulatory design is the primary determinant of compatibility, with ownership traditions and technology playing secondary roles. Effective harmonization requires legal recognition of ECs and coherent integration with national infrastructure and markets. These findings suggest that differences in regulatory design shape the conditions under which ECs can emerge and scale, thereby influencing their potential contribution to the energy transition, including the pace and scope of decentralised renewable energy deployment.

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