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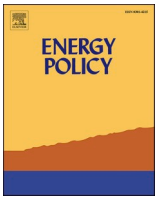

Energy communities in the energy transition: A research-practice agenda from the Netherlands

Daniel Petrovics [a,b,*], Thomas Bauwens [a], Björn Hoops [c], Lea Diestelmeier [c], Floor Alkemade [d], Frans Coenen [e], Javanshir Fouladvand [f], Amineh Ghorbani [g], Johanna Höffken [d], Thomas Hoppe [e], Nenya Jochemsen [f], René Kemp [h], Matthijs Punt [f], Pepijn Quast [f], Luc van Summeren [d], Beau Warbroek [i], Anna Wieczorek [d], Julia M. Wittmayer [j,m], Mendel Giezen [k], Ilonka Marselis [l], Flor Avelino [f], Sanne Akerboom [f]

[a] *Rotterdam School of Management, Erasmus Universiteit Rotterdam, the Netherlands*
[b] *Faculty of Governance and Global Affairs, Leiden University, the Netherlands*
[c] *Faculty of Law, University of Groningen, the Netherlands*
[d] *Faculty of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, the Netherlands*
[e] *Faculty of Behavioural Management and Social Sciences, University of Twente, the Netherlands*
[f] *Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands*
[g] *Faculty of Technology, Policy and Management, Delft University of Technology, the Netherlands*
[h] *Maastricht Sustainability Institute, University of Maastricht, the Netherlands*
[i] *Faculty of Engineering Technology, University of Twente, the Netherlands*
[j] *Erasmus School of Philosophy, Erasmus Universiteit Rotterdam, the Netherlands*
[k] *Faculty of Social and Behavioural Sciences, University of Amsterdam, the Netherlands*
[l] *Energie Samen, the Netherlands*
[m] *Dutch Research Institute for Transitions, the Netherlands*

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A B S T R A C T

Energy communities are no longer peripheral experiments in Europe but central actors in the energy transition. Their growth and institutionalization is particularly observable in the Dutch context. By 2024, 702 cooperatives engaged over 139,000 members across nearly 90% of municipalities - evidence that the energy transition is societal as much as technical. In the Dutch context, communities can accelerate and democratise change by raising acceptance of renewable energy projects, mobilising local capital and building energy literacy and trust. The Netherlands is a uniquely fertile testbed for integrating bottom-up change: a polycentric governance setting, a dense cooperative ecosystem, rapid digitalisation and high distributed generation all push communities beyond renewable energy deployment towards new activities, such as storage and demand-side flexibility. Yet, practice still outpaces legal, policy and technical frameworks. Unresolved tensions in regulation, legitimacy, justice, impact evaluation, system integration, and scaling reveal that energy communities remain under-leveraged. This perspective advances a research agenda to close that gap, co-created with Energie Samen, the Dutch federation of energy communities, and informed by targeted literature synthesis, roundtables, and practitioner interviews, to pinpoint where knowledge is most urgently needed to align rules and markets with citizen-led innovation. While our perspective is focused on the Netherlands, the lessons are transposable if contextualized to other legal, market and social conditions. Accordingly, we suggest that without deliberate coordination between research, policy, and practice, the potential of energy communities will be left on the table just when it matters most.

* Corresponding author. Rotterdam School of Management, Erasmus Universiteit Rotterdam, the Netherlands.
E-mail addresses: petrovics@rsm.nl, d.petrovics@fgga.leidenuniv.nl (D. Petrovics).

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1. Introduction: purpose, scope and approach

The European energy transition is increasingly citizen-led. With wind cooperatives proliferating across countries such as Belgium or the UK (Bauwens et al., 2016), the institutionalization of thermal energy communities in Denmark and the Netherlands (Herreras Martínez et al., 2025) alongside the substantive inter-organisational embedding of energy communities in Germany (Punt et al., 2022), it is clear that citizens are no longer only passive consumers or producers of energy.

The Dutch context is particularly illustrative of these developments. What began a decade ago as a handful of initiatives has become a nationwide civic infrastructure: hundreds of cooperatives generating electricity and heat, investing local capital, and partnering with municipalities and distribution system operators (DSOs), amassing capacity, social capital and policy influence (HIER, 2024; Geskus et al., 2024). The Dutch Climate Agreement (House of Representatives, 2019) set the ambition of 50% local ownership of renewable energy production installations. In September 2025, the government published an even more ambitious policy vision positioning energy communities (ECs) – groups of citizens, businesses, or local governments jointly generating, consuming, storing, and sharing renewable energy with a focus on local ownership and social value – as long-term governance actors at the heart of the transition (Ministerie van Klimaat en Groene Groei, 2025).

That policy outlines a three-part strategy: strengthen ECs' institutional role alongside state and market; broaden participation so all citizens and SMEs can benefit; and build a support framework for professionalisation and scaling. Measures include substantial funding for provincial and regional umbrellas (training, technical support, legal advice); positioning one-person-one-vote decision-making as a condition for public funding; funding research into barriers and drivers towards achieving 50% local ownership; and supporting learning networks and community work (*opbouwwerk*) to build capacity in underrepresented areas. Legally, the new Energy Law (*Energiewet*) (effective since January 2026) grants ECs the rights to supply energy and provide flexibility services. The Collective Heating Law (*Wet Collectieve Warmte [Wcw]*) (passed in parliament, effective as of January 2027) establishes framework conditions for community- and municipality-led heat networks. Additional policy actions include exploring equity and guarantee funds, piloting integrated multi-commodity energy hubs, active financing of regional federations to strengthen regional capacity building and developing intermediary roles such as "energy sharing organisers". Together, these measures mark a decisive shift from incidental project support to structural support and the institutionalization of ECs, with timelines running from late-2025 research activities to multi-year programmes (2026-2028). Scenario estimates suggest that ECs could plausibly supply 20% of solar generation, over 50% of onshore wind, and 25% of heat by 2050 (CE Delft, 2024).

The Netherlands is a distinctive case in Europe: ECs operate in an increasingly polycentric architecture (spanning local to national levels while involving municipalities, private actors, and communities under shared governance rules) and are institutionally recognized actors (Ministerie van Economische Zaken en Klimaat, 2026). This positioning grants them formal entry points into public decision-making (Petrovics et al., 2022). Regional energy strategies (RES) and municipal heat planning offer structured venues where citizen groups co-set priorities with local governments and system actors (Hoppe et al., 2015; Oteman et al., 2014; Hoppe, 2021; Teladia and van der Windt, 2024). These institutional entry-points are backed by a dense cooperative ecosystem – federated support structures, shared services, and model statutes – enabling professionalisation without sacrificing member control (Hufen and Koppenjan, 2015; Warbroek and Hoppe, 2017). Faced with highly distributed generation, rapid digitalisation, rising energy poverty, and severe grid congestion, ECs are pushed towards creating multi-commodity energy communities: moving beyond renewable deployment into coordinated flexibility, storage, and demand-side management. These organisational developments are well documented in the community energy and integrated community energy systems literature (Koirala et al., 2016). Together the aspects of formalised entry points, mature cooperative ecosystems, and system pressures favouring flexibility shape what Dutch ECs can do, and what research and policy support they require.

This perspective paper argues that Dutch ECs can accelerate and democratise the energy transition by addressing acceptance and resistance, mobilising local capital, and building energy literacy and trust (Hogan et al., 2022). Evidence from the Netherlands and beyond links co-ownership to higher resident support (Bauwens and Devine-Wright, 2018) and shows ECs reinvesting surpluses in efficiency, poverty alleviation, and neighbourhood services (Sovacool et al., 2023). These initiatives illustrate an alternative paradigm of energy governance "beyond markets and states," reshaping society and the economy amidst the climate crisis (Bauwens et al., 2022; van Summeren et al., 2023). Organisations such as Energie Samen, the Dutch federation of ECs, underpin this movement through knowledge exchange, shared finance, capacity building, and advocacy (Bauwens et al., 2025).

Yet, momentum alone will not ensure impact. ECs still face ambiguous regulation, system complexity, scaling challenges, resistance from fossil fuel lobbies and commercial companies, volunteer capacity limits, and justice and legitimacy questions (Avelino et al., 2023; De Simone et al., 2025; Vardanyan, 2025). Practitioners often innovate faster than policy evolves, while academics too rarely generate knowledge that translates into everyday decisions. Bridging this gap is essential if ECs are to realise their transformative potential. We position Dutch ECs as system-shaping actors and identify the knowledge gaps limiting their contribution. Combining scholarly insight with field experience, we set a shared research agenda to accelerate, broaden, and democratise the transition.

Our focus is firmly on the Dutch context and problem-driven: rather than a conventional literature review, we ask what organisers, advocates, and policymakers need to know now and how researchers can generate timely knowledge for real-world decisions. We adopt a critical, justice-oriented lens: we examine where ECs succeed, where they fall short, and which design choices improve outcomes. While rooted in Dutch institutions, energy systems, and housing realities, the agenda is transposable elsewhere if translated to local law, market design and social fabric.

Methodologically, the paper draws on an iterative, transdisciplinary co-creation process involving a targeted literature synthesis, stakeholder dialogues, and author-led interviews. Through a roundtable discussion between the authors of this paper and Energie Samen in the spring of 2025 we identified the most pressing challenges in practice. Considering Energie Samen is a member-based organization with ECs and regional chapters being their only members, they are well-suited to represent the voice of the Dutch EC movement. Their input into the priority topics has resulted from continuous dialogue with all their members (ECs), as well as through targeted thematic working groups with their members to hear challenges and successes on the ground. Then, through an iterative

process, we aligned these results with gaps in literature alongside scholarship from on-going and completed projects the author team had worked on.[1] We incorporated knowledge from literature reviews, stakeholder dialogues and roundtables as well as primary data from these projects. Through this iterative process, we refined research questions until our overview of the needs of practice and scholarly inquiry converged.

In the following, we first summarize the benefits of ECs. Then, the perspective proceeds through six thematic sections reflecting practitioner priorities based on the work of Energie Samen on the ground. The thematic sections focus on ECs' (i) legal position, (ii) legitimacy, (iii) energy justice, (iv) societal impact metrics, (v) integrated energy systems, and (vi) scaling pathways. Each combines leading evidence with field experience, identifies blind spots, and proposes research directions and reflects on the transferability of policy directions to other contexts, before a final synthesis on steering the Dutch energy system on a more democratic, transformative, and equitable path.

2. Benefits of energy communities

ECs multifaceted contributions span systemic, social, equitable, and economic domains, reflecting their potential to support not only energy transitions but also broader societal goals. This section outlines these four dimensions of value creation, drawing on recent empirical evidence from the Dutch context.

Systemic. ECs contribute to distributed generation and, increasingly, to the flexibility the Dutch system needs. ECs are piloting storage and local optimisation: Betuwewind's, Deltawind's and De Windvogel's community batteries, launched in 2024 and 2025, illustrate how ECs can relieve congestion and join energy markets in new roles (De Windvogel, 2025). Community-based virtual power plant pilots (e.g. Local4Local, SmartCORE, Joule4Joule, DE-centrale Loenen) further demonstrate that pooled assets can deliver system services under real Dutch regulatory conditions (Mourik et al., 2019; van Summeren et al., 2021).

Social. Co-ownership and benefit sharing enhance participation, independence, the overall success of community-led projects and lead to the acceptance of renewables (Koirala et al., 2018; Fouladvand et al., 2022a; Ghorbani et al., 2020). A comparative study of fourteen Dutch onshore wind projects reveals that community ownership is associated with fewer appeals and shorter development times compared to commercial projects, indicating smoother local processes (Brouwer et al., 2025). Dutch cases also demonstrate how ECs strengthen civic capacity and foster municipal partnerships (Brouwer et al., 2025). Citizen-led renovation projects by ECs are likewise more effective in tackling energy poverty and reducing energy use than non-citizen initiatives (TNO, 2024). ECs also create stronger social networks in pre-existing communities (Geskus et al., 2024), which can contribute to raising societal resilience.

Equity. ECs seek to democratise processes and ensure just benefit distribution. Research documents socio-spatial inequalities in access to solar PV benefits highlighting why ECs partner with housing associations and offer low-threshold participation for tenants and lower-income households (Kraaijvanger et al., 2023). Democratic governance (one-member-one-vote) further decouples decision power from investment size, while building models that separate the cost price from levied tariffs before entering electricity markets offers long-term stability, transparency and predictability of energy prices (REScoop, 2026).

Economic. ECs also retain value locally. Members have invested about €185 million in operating Dutch cooperative wind and solar, and ECs contribute several million euros annually to community funds supporting local public goods - reinvestment beyond kilowatt-hours (HIER, 2024). ECs also create local jobs and knowledge. Specifically, citizen-led retrofitting has allowed for the training and integration of people with a distance to the job market (van Tuijl et al., 2024).

These benefits are conditional, as they become routine when legal roles are clear, market access is proportionate, interoperability with DSOs is purposefully designed, and governance stays inclusive as organisations professionalise. The following research priorities explore these conditionalities.

3. Priority research topics

3.1. Legal position of energy communities

EU Directives 2018/2001 and 2019/944 introduced citizen and renewable energy communities; the Netherlands transposed these by recognising '*energiegemeenschappen*' in the Energy Law (2024) and, for heat, '*warmtegemeenschappen*' in the Collective Heat Law (*Wet collectieve warmte* (Diestelmeier, 2021; Diestelmeier et al., 2021)). Before these Laws, ECs operated under fragmented arrangements with cumbersome rules on grid access, licensing, and revenue models. Legal recognition is necessary but insufficient as core aspects of ECs' position in the energy sector (rights, duties, permissible activities, and relationships with public authorities) remain unresolved. Even the Climate Agreement's 50% local ownership ambition requires additional regulation to give participation a clear legal basis and purpose.

Form and governance. The Dutch Energy Law does not prescribe a single legal form. ECs must meet EU and national requirements on purpose and member control, while selecting structures that fit their activities in electricity and/or heat. Practitioners often combine a cooperative ('*coöperatie*') with private limited companies ('*B.V.*') and/or foundations ('*stichting*') (Hoops et al., 2025). What is missing is systematic evidence on permissible combinations, such as participating in a project B.V. while retaining EC status, drafting contracts for co-ownership and sharing decisions with other types of shareholders - and their suitability for different purposes or risk profiles. Comparative EU research, co-produced with practitioners, could deliver model statutes for common EC archetypes and cut transaction costs.

Activities and market roles. Most Dutch ECs are producers (HIER, 2024); some transition into collective supply, assuming direct responsibilities to customers and system operators (Buijze et al., 2021; Winters and van der Veen, 2023). Energy sharing, which blurs the line between (self-)production and supply remains legally undefined (Diestelmeier and Cappelli, 2023; Giarmanà, 2023; Kalisvaart, 2023), although comparative research identifies emerging regulatory solutions and remaining challenges (Chen et al., 2025). Experiments such as the government-funded 'Local4Local' project show how activity, purpose, and legal form intersect. Legal scholarship should target this intersection by clarifying energy-sharing rights, governance, and consumer protection to enable communities to operate with confidence.

Procurement and state aid. A further grey zone concerns public procurement and state aid. ECs are not conventional market actors, yet their cooperative form qualifies them as an enterprise (*onderneming*), creating uncertainty about EU-law status and permissible public support (Energie Samen, 2025a). As a result, municipalities lack clarity on when they can directly award contracts or allocate land without procurement procedures, or how much financial support is permissible without

[1] The author team has worked on, or drawn directly on experience from (among others), the following energy-community and related transition projects: Private Law and the Energy Commons, Marie Skłodowska-Curie Actions; Adaptive participatory strategies to foster acceptability and fairness in bottom-up energy initiatives, Ubbo Emmius Foundation / Wubbo Ockels School of Energy and Climate; Flexible Energy Communities, NWO-KIC; Smart Energy Region Emmen-Haren, Interreg; Smart Regimes for Smart Grids, NWO; cVPP, Interreg North-West Europe; SmartCORE, Interreg North-West Europe; ORAKLE, NWO-MARET; REScoop Plus, Horizon 2020; SCCALE 20-30-50, Horizon 2020; SHIFFT, Interreg 2 Seas; JUSTPREPARE, NWO; PREFIGURE, Horizon Europe; SUSTENANCE, Horizon 2020; SERENE, Horizon 2020; CIRCUS, Interreg North-West Europe; Every1, Horizon Europe; SCENTISS, NWO-KIC; SCENSUS, ERC Starting Grant; NEWCOMERS, Horizon 2020; EmPowerED, NWO-ORC.

violating state aid rules. Clear guidance or targeted legislative clarification, which are seldom organized by the national government and municipalities, are needed to avoid chilling effects on partnerships.

Regulatory stance. Tensions remain between regulation and community practice (Huygen and Akerboom, 2020). Strict regimes governing system operators and the Dutch Authority for Consumers and Markets (ACM) raise questions about the scope of governmental regulation (cf. Giarmanà, 2023; Kalisvaart, 2023; Chen et al., 2025) alongside the regulatory grey-zone around prosumership as a part of the relationship between governments and ECs (Hoops, 2026). Policymakers must also decide whether to strengthen the framework through technical norms (e.g. NEN standards) (Energie Samen, 2025) or adopt facilitative legislation linking fragmented legal subfields (cf. (Huygen and Akerboom, 2020; Kaschny and Lavrijssen, 2023)). Understanding how communities navigate these gaps and defining what a coherent Dutch legal framework requires remains a priority.

3.1.1. Research questions

1. How should regulation structure permissible combinations of cooperative, private limited, and foundation forms - and the associated rights for energy sharing and collective supply - so that ECs can retain member control while operating effectively across electricity and heat?
2. What procurement, state-aid, regulatory, and technical-standard clarifications are needed to enable lawful community–municipal partnerships and proportionate participation by ECs in grid access and flexibility markets?

Policy Reflections. Policy should convert formal legal recognition into an operational framework for legal form, energy sharing, and community–municipal contracting, especially if the Dutch 50% local-ownership ambition is to have practical effect. This direction is transferable across Europe, but its uptake depends on conditions such as legal recognition of energy communities, municipal authority in land and heat governance, and the availability of community-specific procurement and state-aid guidance.

3.2. Legitimacy of energy communities

To realise their potential in the Dutch energy transition, ECs require recognition and structural support, or in short, legitimacy (Bauwens and Devine-Wright, 2018; van der Schoor et al., 2016; Wagemans et al., 2019). Because ECs are a relatively novel organisational form, many stakeholders remain unfamiliar with how they operate, making legitimacy a recurring concern (Genus and Iskandarova, 2020; Huybrechts and Haugh, 2018). Early Dutch community initiatives were normatively driven and operating largely outside formal arenas. Becoming part of core energy governance requires professionalisation and support infrastructures and thus broader forms of legitimacy at the individual, organisational and field levels (Hufen and Koppenjan, 2015; Hoppe and Warbroek, 2021; Jochemsen et al., 2024).

Individual level. Within communities, diverse member motivations (financial, environmental, civic) and reliance on heterogeneous stakeholder networks complicate decision-making (Wagemans et al., 2019; Bauwens, 2016). With member bases and inter-organisational ties still maturing, ECs must perform collective institutional work locally through crafting narratives, routines and roles that reconcile diversity while sustaining participation (Jochemsen et al., 2024). Through government financing, Energie Samen has created a capacity training for ECs (*krachttraining voor energiegemeenschappen*) to help train individuals in collective decision-making, conflict resolution and collective ownership - skills largely lacking in individuals joining ECs (Energie Samen, 2026).

Organizational level. Externally, municipal officials may underrecognise EC contributions to local objectives, while residents can misread participation opportunities and benefits (HIER, 2024; European Commission, 2025a). Performance criteria used in tenders and funding (often narrowly market-oriented and quantitative) risk delegitimising ECs when they do not capture public-value outcomes (participation, local benefit, flexibility) (European Commission, 2025a; Berka et al., 2020; Yiasoumas et al., 2023). Misaligned expectations can push communities either to compromise core values or exit collaborations. Reframing evaluation around appropriate indicators, building on emerging KPI sets for ECs, would better align organisational strategies and external assessments (Giannuzzo et al., 2025; Peeters et al., 2025; Panwar et al., 2014).

Field level. At system scale, legitimacy is negotiated among state, market and civil actors (Sareen and Haarstad, 2020). EU Directives have granted policy and legal recognition, but in practice ECs are still treated instrumentally at the margins of Dutch planning and market design (Ministerie van Klimaat en Groene Groei, 2025). Ongoing debates about ECs' transformative roles raise a central question: in which roles are ECs legitimate today, and how can this scope be expanded (Genus and Iskandarova, 2020; Moroni et al., 2019)? Addressing this requires making concepts and minimum criteria more explicit so successful practices can be abstracted and replicated without erasing local variety, and so corporate capture is avoided (Bauwens et al., 2022; Cloke et al., 2017; Envall and Rohracher, 2024).

Across levels, a core tension persists. ECs are expected to emphasise their distinct competences (locality, collectivity, flexibility) (Moroni et al., 2019) while simultaneously mirroring incumbent forms (commercial activities, hierarchical management, up-scaling) to secure acceptance and access (Bauwens et al., 2022; Summeren et al., 2023). The potential is system reconfiguration, while the risk is a drift from normative distinctiveness to institutional conformity (Wittmayer et al., 2021). Guiding ECs' institutional evolution, therefore, requires evidence on how different strategies influence legitimacy over time and anticipates shifts in what policymakers and markets see as legitimate (Drori and Honig, 2013; de Geus et al., 2022).

3.2.1. Research questions

1. How do different individual professionalisation trajectories and role choices shape the internal, organisational, and field-level legitimacy of ECs over time?
2. Which public-value indicators and minimum governance criteria should tenders, funding schemes, and policy frameworks use to recognise ECs' distinctive contributions without forcing institutional conformity or enabling corporate capture? And how can municipalities implement them?

Policy reflections. Policy should recognise ECs as public-value actors by aligning tenders, funding, and planning rules with participation, local benefit, and flexibility, while clarifying the roles in which they are considered legitimate. This is transferable to other European contexts, but it depends strongly on cooperative density, intermediary support structures, and municipal willingness to treat communities as credible partners.

3.3. Design principles of energy justice

In the Netherlands, justice-by-design for ECs centres on membership, benefits, and decision-making within existing institutions. We use three context-specific justice lenses: distributional (who pays and benefits), procedural (who participates and how), and recognitional (whose needs count) (Sovacool and Dworkin, 2015). Designing for justice must also reflect Dutch realities: a housing market with 43% rental dwellings (Compendium voor de Leefomgeving, 2024), neighbourhoods experiencing energy poverty, and diverse stakeholders (municipalities, DSOs and TSOs) shaping connection and transmission or distribution agreements (van Dijk et al., 2022; Lavrijssen et al., 2021).

Distributional. The priority is lowering barriers so tenants and low-income households can participate fairly. This involves tailoring cooperative shares and savings products to small monthly contributions. Such decoupling of membership and voting rights from capital stake (consistent with EU community-energy provisions on open, voluntary participation and member control) can help people join without compulsory investment (Diestelmeier, 2021; European Commission, 2025b). Partnering with housing associations (*woningcorporaties*) can aid rooftop PV and surplus sharing to reach tenants and allocate part of project surpluses to targeted measures (efficiency upgrades, arrears prevention). This can also help realise complex projects, such as district heating projects (Onencan et al., 2024). Dutch evidence shows why this matters, as energy poverty has a clear socio-spatial footprint, and PV benefits are often uneven (Kraaijvanger et al., 2023). Where communities organise heat, affordability guarantees and transparent indexation in concessions are vital to avoid reproducing inequalities.

Procedural. Legitimacy increases when ECs are embedded in decision-making processes. Early involvement of neighbourhood councils and social organisations, alignment with RES and municipal heat plans, and plain-language reporting help translate member control into public accountability. Research on RES regions shows that multi-level coordination is key to fair outcomes, supporting proportional compliance: consumer-protection and market-entry rules should safeguard end-users without imposing corporate-scale burdens on small ECs, especially in low-risk energy-sharing pilots (van Dijk et al., 2022).

Recognitional. Membership often skews toward homeowners and highly educated, native-born men, with other groups underrepresented (Goedkoop et al., 2025), even with a diversity of values among different ECs present (Melnyk et al., 2023). A justice-oriented approach recognises heterogeneity in needs and adapts outreach: recruiting and training energy coaches from marginalised groups, holding assemblies at accessible times and venues, providing multilingual materials, and reserving board or advisory roles for tenants and low-income members. Without such measures, benefits risk concentrating unevenly (van Bommel and Höffken, 2021; van Uffelen, 2024). Despite this, ECs tend to benefit their broader surroundings and communities (also involving non-members). For example, the Warm Assendorp community heating network is found in an area with an exceptionally high-level of energy poverty, and the project explicitly aims to benefit the whole neighbourhood, not just its members (Warm Assendorp, 2026).

Operationalisation. Simple and auditable rules can assist ECs to commit to inclusion targets and cap the concentration of individual benefits (building on REScoop-style and Local4Local charters). Municipalities can embed standards in procurement and public-roof allocation while DSOs and regulators can support pilots with energy sharing and solidarity tariffs. Underscoring this, monitoring should go beyond kWh to track participation by tenure and income, distribution of financial and non-financial benefits, and perceived fairness. Justice oriented governance frameworks should offer handles for cooperative statutes, concession terms, and tender criteria, to help specify justice ex ante, not assert it ex post (Lavrijssen et al., 2021).

Where to test. Justice design is best tested where tensions are sharpest: congested grids (risking exclusion of smaller actors), mixed-tenure neighbourhoods (tenant participation depends on housing association deals), and low-income areas (where surplus-sharing and efficiency reinvestment can reduce energy poverty). Linking such experiments to the Energy and Collective Heating Laws will reveal which combinations of cooperative governance, municipal tools, and proportionate regulation deliver fairness at scale.

3.3.1. Research questions

1. Which institutional arrangements among energy communities, municipalities, housing associations, and DSOs best secure distributional, procedural, and recognitional justice in collective solar, heat, and energy-sharing initiatives, especially for tenants and low-income households?
2. How can justice-by-design be embedded in cooperative statutes, concession terms, tender criteria, and proportional regulation, and with what effects on socio-spatial inequality, non-member cost allocation, and perceived fairness?

Policy reflections. Policy should embed justice ex ante through low-threshold participation, tenant-inclusive benefit-sharing, proportional compliance, and explicit fairness criteria in statutes, concessions, procurement, and regulation. Transferability is strongest where municipalities and social-housing actors play roles comparable to the Dutch case; this depends particularly on housing-tenure structures, municipal and DSO coordination, grid congestion, and heat-transition governance.

3.4. Societal impact metrics

ECs generate societal value that standard energy statistics miss, such as empowerment and participation, local wellbeing and jobs, education and energy citizenship and democracy, support for social initiatives, and elements of energy justice. ECs can also curb energy poverty through home-energy measures and tailored incentives (Coenen and Hoppe, 2022), and with external stakeholders reduce resistance to climate policies by strengthening community cohesion (Allen et al., 2019). Policy actors in the Netherlands tend to emphasise ECs' instrumental contribution to transition targets, while scholarship increasingly highlights their democratising potential and capacity to reorient the energy system (Coenen and Hoppe, 2022; Wittmayer et al., 2022; van Veelen, 2018).

Existing tools. In recent years, EC-relevant KPIs and evaluation frameworks have expanded (Giannuzzo et al., 2025), alongside Dutch social innovation approaches that move beyond summative "scorecards". Drawing on developmental evaluation (Patton, 2010) and Transformative Social Innovation (Pel et al., 2020), tools such as the SCALE 3D (Strasser and de Kraker, 2023), the Energy Communities Development Progress Tool (Hoppe et al., 2023) and transformation-focused evaluation principles (Buckton et al., 2025) help ECs clarify goals, align activities with a theory of change, navigate context and power dynamics, and turn monitoring data into concrete course corrections to grow societal impact.

Inclusivity gaps. Most performance monitoring by governments, umbrellas, universities and EU projects, remains technical and financial, focusing on installed capacity, project counts, euros invested and organisational size. Few initiatives track societal outcomes in depth, and empirical analyses of transformative agency and its co-determinants are rare. But a just energy transition also requires shifts in norms, values, and behaviours: new social contracts between public institutions and civil society, and active, informed energy citizenship, which current dashboards barely capture (Melnyk et al., 2023).

Looking ahead, EU-level monitoring will likely become more standardised, but widespread adoption of societal impact indicators, particularly for transformative agency, will take time. Still, attention to justice, inclusion, energy citizenship, and energy poverty is rising. Transformation-focused evaluation offers principles on complexity, power, and purpose (Buckton et al., 2025); SCALE 3D and the EC Progress Tool support iterative learning that integrates purpose and inclusion into day-to-day practice.

3.4.1. Research questions

1. What indicator set can credibly capture the societal impact of ECs - including justice, inclusion, energy citizenship, empowerment, and affordability in electricity and heat - alongside technical and financial performance?
2. How can reflexive, learning-oriented evaluation systems integrate qualitative social evidence with quantitative energy data in

community practice, public funding, and intermediary support without undermining community autonomy?

Policy reflections. Dutch monitoring should move beyond capacity, project counts, and euros invested to a mixed-method, learning-oriented framework that tracks empowerment, inclusion, energy citizenship, justice, and affordability alongside energy outputs. This approach is broadly transferable, but routine adoption depends on administrative capacity, data governance, and the presence of umbrella and intermediary organisations able to sustain iterative evaluation.

3.5. System integration

System integration has two inseparable layers: the technical stitching of resources across various energy domains, and the institutional knitting of governance scales. Technical integration means the functional combination of various carriers (electricity, heat or combined), digital technologies, renewable energy sources, integrated mobility solutions and infrastructures; while institutional integration entails the enabling of self-sufficient, grid-connected and hybrid ECs in the energy system. Without addressing both, Dutch ECs risk remaining siloed and underdelivering.

Technical. For ECs, technical integration means coordinated planning, operation, and management of distributed generation (solar PV, on and off-shore wind, and heat), storage (batteries) and flexible demand (often via a local energy hub) coupled to DSO infrastructure and market interfaces. Advanced optimisation (e.g., model-predictive control and robust scheduling) manages renewable and demand uncertainty so communities can operate reliably and cost-effectively (Dini et al., 2022; Good and Mancarella, 2019; Wang et al., 2024). Integration enables local energy sharing and joint demand response in local energy markets, and at higher levels participation in balancing and congestion-relief (Li et al., 2023; Siqin et al., 2022). Integration not only plays a decisive role in the energy security of ECs but also the security of the energy system, when ECs become central players in the system (Fouladvand et al., 2022a). This is particularly so if they have the ability to contribute to collective system optimisation - where they support grid stability and system services - and establish collective autonomy - through community-driven micro-grids or cVPPs focused on self-sufficiency for example (Wieczorek et al., 2024).

Institutional. The institutional layer is equally important. Multi-level governance must link EC pipelines to municipal plans and RES processes and synchronise with DSO reinforcement schedules and flexibility needs alongside finding synergies between heat and electricity. Such an approach would benefit ECs alongside the national energy system (Fouladvand et al., 2024; Wejnert-Depue et al., 2025). Clear democratic routines (mandates, accountability, dispute resolution) build trust and legitimacy (van Veelen, 2018; Acosta et al., 2018). Enablers include proportionate grid access policies, consumer protection tailored to collective supply and sharing, and sustained capacity building through regional intermediaries (Leonhardt et al., 2022; Markantoni, 2016). With grid congestion widespread, predictable queueing and prioritisation rules, and explicit recognition of community projects in connection and curtailment procedures, are now part of the integration agenda.

Local integration. Locally, integration is the choreography of renewable energy sources, storage technology, Energy Management Systems (EMS), control strategies and their shared use. Systemically, interoperability with the grid, safe bi-directional flows, voltage management, Power-to-Heat solutions, standardised codes and market participation must align with coordinated governance and harmonised policies (Shafiullah et al., 2013; Wainer et al., 2022). These choices also shape bankability. Although integrated PV-storage-flex portfolios reinforce each other technically, financing and construction often proceed asynchronously, leading lenders to assess each component separately (with separate risk premia), rather than as a single system value proposition.

Key obstacles. Many ECs still lack coordinated EMS across generation, storage and load, a legacy of policies that rewarded production but not local balancing (Koirala et al., 2016). On the grid side, congestion, bidirectional flow constraints, voltage instability, and the lack of standardised codes impede scaling (Shafiullah et al., 2013). Interoperability gaps and immature EMS remain (van Summeren et al., 2021), while spatial mismatches between new ECs and substation capacity add friction. Institutionally, responsibilities are fragmented, procurement and compliance routines are calibrated for incumbents, and peer-to-peer (P2P) or energy-as-a-service (EaaS) models face regulatory inertia. Evidence suggests that digitalisation enables community VPPs to aggregate small assets for market access while retaining democratic control (van Summeren et al., 2021; van Summeren et al., 2022). Cooperative aggregation helps overcome scale barriers and opens new revenue streams (Summeren et al., 2023). Decision-support tools help municipalities and ECs weigh technical–economic–social trade-offs (Loomans and Alkemade, 2024).

Heat is the next frontier: integrating heat communities with electricity-side flexibility is vital but institutionally and technically demanding (Fouladvand et al., 2022b). Local electricity markets could improve inclusivity and efficiency, but price-formation and settlement design remain under-specified for Dutch conditions (van den Berghe and Wieczorek, 2022; van de Water et al., 2025). To avoid lock-ins, research and policy should prioritise open standards and interoperability, and tailor digital tools to local capacities (Wieczorek et al., 2024).

3.5.1. Research questions

1. What governance and regulatory arrangements enable the co-evolution of technical integration and institutional coordination between ECs, municipalities, DSOs, and markets under conditions of grid congestion?
2. How can open standards, secure data interfaces, local energy markets, community virtual power plants, and electricity–heat coupling be designed so ECs deliver flexibility and local value without compromising democratic control, inclusivity, or system reliability?

Policy reflection. System-integration policy should jointly align interoperable EMS and data standards with municipal planning, DSO queueing and curtailment rules, and proportionate sandbox regulation so communities can deliver flexibility and couple heat with electricity. The general direction is transferable to other decentralising systems, but its urgency and design depend heavily on aspects like grid congestion, digitalisation, and formal municipal roles in heat planning and regional energy strategies.

3.6. Scaling pathways

Despite their breadth and depth, Dutch energy communities still contribute only modestly to the national mix (~1–2% PV, ~5% wind) (HIER, 2024). Barriers include limited finance, technical expertise, and professional management while many initiatives remain volunteer-based (de Bakker et al., 2020; Warbroek, 2019) and faced by resistance from incumbent actors (Proka et al., 2018). Hybrid partnerships with municipalities or energy firms can unlock scale but risk eroding grassroots autonomy (Bauwens et al., 2022; Petrovics et al., 2024a). Policies such as the Postcode Rose (*postcoderoos*) tax scheme, the SCE subsidy, and the SDE++ scheme have nonetheless supported local production (Oteman et al., 2014; Petrovics et al., 2024b).

Scaling strategies. Dutch ECs pursue multiple scaling strategies: scale-up through growth (kW or Ah as well as member-base) and professionalisation; scale-out by diversifying services (from production through storage to demand-end response); scale-deep through local engagement and institutionalization; and scale-across via replication through federations like Energie Samen (Bauwens et al., 2020). Pooling resources through regional and national federations enables small ECs to

access expertise and finance while maintaining local control. Purpose-built organisations, such as cooperative suppliers that buffer market volatility (Bauwens et al., 2022; Summeren et al., 2023) and cooperative aggregators that monetise flexibility across multiple ECs via shared EMS (van Summeren et al., 2022) help align scaling with ECs' missions.

New synergies. To move beyond niche networks, ECs must engage wider actor constellations and link with adjacent domains. Cross-sector ties with climate adaptation (Cloutier et al., 2018; McNamara et al., 2020; Mees et al., 2019) local food systems (Lamalice et al., 2018; Ulug and Horlings, 2019), or new housing developments remain underexploited, despite synergies highlighted in water–energy–food research (Meir et al., 2022) and multi-system transition work (Rosenbloom, 2020; Käsbohrer et al., 2024; Wesche and Skjølsvold, 2025). Low-cost on-ramps such as community agriculture or garden depaving can broaden participation, while intermediaries can act as system entanglers, brokering ties across sectors (Löhr and Chlebna, 2023). Scaling must also confront Dutch grid congestion head-on: where capacity is scarce, flexibility provision and coordinated siting are prerequisites for growth.

Scaling tensions. Forthcoming policy and technological convergence will accelerate scaling but sharpen tensions between locally focused ECs pursuing socio-environmental goals and representative organisations positioning for system-level roles (Warbroek et al., 2018). ECs still rely on external expertise and face difficulties expanding customer bases (Hoppe and Warbroek, 2021). Legislative support for community-led heat networks could extend the model to heat (de Bakker et al., 2020), while scaling citizen-led renovation depends heavily on long-term financing (Energie Samen, 2025b). Partnerships with housing associations and municipalities will likely boost solar deployment on social housing (Petrovics et al., 2024a, 2024b). Through all of this, participatory governance must be maintained to avoid mission drift and for energy system transformation, even as normalising renewables and everyday pro-sustainability practices becomes a core impact of ECs (Delina, 2020; Pesch et al., 2019).

3.6.1. *Research questions*

1. How do scale-up, scale-out, scale-deep, and scale-across strategies interact in ECs, and which combinations best expand flexibility provision and social value while preserving member control?
2. Which federative, financial, and cross-sector partnership arrangements - including those involving municipalities, housing associations, utilities, and intermediaries - most effectively support fair scaling in congested-grid regions without mission drift?

Policy reflections. Scaling policy should strengthen federative infrastructures, long-term finance, and mission-preserving partnerships so communities can diversify into flexibility, renovation, and heat while retaining participatory governance. This is transferable across Europe, but success depends particularly on aspects such as cooperative density, local ownership targets, municipal and housing-association partnerships, and the combined pressures of grid congestion and heat-transition governance.

4. Conclusion: the future potential of Dutch energy communities and the role of science

Dutch ECs have moved from grassroots initiatives to recognized system actors. Using a justice-oriented, practice-informed, problem-driven lens, this perspective sets a research agenda grounded in this reality. It targets core constraints: legal ambiguity, multi-level governance and system-integration challenges, scaling without losing democratic legitimacy, uneven inclusion and benefit distribution, and the thin evidence base on societal impact.

The Dutch case is distinctive; however the lessons also travel to other contexts – primarily in Europe. Across decentralising systems, legal recognition alone does not resolve operational uncertainty; integration into technical and governance infrastructures demands deliberate institutional design; and justice as well as broader transformative ambitions are easily eroded by the pressures to professionalise, scale, and compete in liberalised markets.

For this reason, we put forward a diagnostic and connective agenda. The six topics - (i) legal position, (ii) legitimacy, (iii) energy justice, (iv) societal impact metrics, (v) system integration, and (vi) scaling pathways - sit in distinct scholarly traditions but must be bridged. In a field marked by normative, disciplinary debates, integration among these topics is essential to move beyond parallel conversations and towards more coherent and collaborative scientific inquiry. Combining legal analysis with socio-technical studies, linking governance research to justice outcomes, and embedding evaluation tools that capture societal and transformative impacts alongside technical and economic metrics can provide an evidence base valuable to researchers, practitioners, and policymakers alike.

This perspective is the product of sustained collaboration between scholars and practitioners in the Netherlands. While calls to bridge theory and practice are longstanding, their transformative potential remains underutilised. Aligning frameworks and markets with citizen-led organisational logics requires deliberate coordination between research, policy, and practice - and comparative work to see which mix of rules, support tools, and intermediary activities allow ECs to become durable system participants without losing their democratic and distributed ground. It also necessitates strong policy-science engagement and collaborative action research processes to raise ECs' contributions.

ECs remind us that energy transitions are social and institutional as much as technical. This highlights capacity to shape energy futures - and prompts reflections on what kinds of futures are desirable. They embody values through how energy is produced, consumed, and managed. Whether they deliver a faster, fairer transition now depends less on community intent than on the regulatory, infrastructural, and political settings around them. The question is no longer if communities can reshape the system, but how quickly institutions will adapt to allow them to do so - and how rigorously engaged science will help chart the way.

CRediT authorship contribution statement

Daniel Petrovics: Conceptualization, Writing – original draft, Writing – review & editing. **Thomas Bauwens:** Conceptualization, Writing – original draft, Writing – review & editing. **Björn Hoops:** Writing – original draft, Writing – review & editing. **Lea Diestelmeier:** Writing – original draft, Writing – review & editing. **Floor Alkemade:** Writing – original draft, Writing – review & editing. **Frans Coenen:** Writing – original draft, Writing – review & editing. **Javanshir Fouladvand:** Writing – original draft, Writing – review & editing. **Amineh Ghorbani:** Writing – original draft, Writing – review & editing. **Johanna Höffken:** Writing – original draft, Writing – review & editing. **Thomas Hoppe:** Writing – original draft, Writing – review & editing. **Nenya Jochemsen:** Writing – original draft, Writing – review & editing. **René Kemp:** Writing – original draft, Writing – review & editing. **Matthijs Punt:** Writing – original draft, Writing – review & editing. **Pepijn Quast:** Writing – original draft, Writing – review & editing. **Luc van Summeren:** Writing – original draft, Writing – review & editing. **Beau Warbroek:** Writing – original draft, Writing – review & editing. **Anna Wieczorek:** Writing – original draft, Writing – review & editing. **Julia M. Wittmayer:** Writing – original draft, Writing – review & editing. **Mendel Giezen:** Writing – review & editing. **Ilonka Marselis:** Conceptualization, Writing – review & editing. **Flor Avelino:** Writing – review & editing. **Sanne Akerboom:** Writing – review & editing.

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Data availability

Data will be made available on request.

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