Promoting Green Lead Market Formation

Cultivating Nordic Lead Markets: Cross-border Collaboration as a Catalyst for Internationalization (NORDLEAD)

Introduction

Finland has long enjoyed a reputation as an innovative country built on high expertise, but its position and economic outlook have weakened. Over the past ten years, investments in research and development (R&D) and high-tech exports have fallen behind Finland's key peer countries, undermining national competitiveness. At the same time, expectations for innovation activities are increasing, not only as enablers of economic growth but also as contributors to sustainability transitions, citizens' wellbeing, and societal resilience.

In recent years, determined steps have been taken to correct the situation. R&D activity is increasing, driven by rising public investments. However, this alone is not enough. Finland's persisting challenge has been translating strong R&D outcomes into successful business in sufficient degree. Many Finnish innovations remain stuck in the so-called valley of death: even with technology successfully developed, its commercialization and scaling are impeded.

Finland's challenge is not weak R&D, but weak translation of R&D into scalable business.

The prevailing national approach to supporting innovation success has been to promote exports and internationalization. Export support is particularly valuable when global markets are already established. However, if the developed innovation does not fit the prevailing market structures and technological systems and realizing its value requires transforming customer practices related to purchasing and use, internationalization faces additional challenges. Creating *lead markets* offers a way to respond to these challenges.

In this policy brief, we introduce lead markets as a rationale for innovation policy with increasing relevance in the context of industrial policy and mission-oriented innovation policy. We discuss relevant policy instruments, policy challenges that should be addressed, and ways to identify promising markets to be prioritised. More specifically, we discuss green lead markets that focus on the adoption of environmentally friendly innovations. Furthermore, we introduce cross-border collaboration as a key dimension to consider for small open economies, such as Finland.

The lead market approach

The concept of lead markets describes regions or countries that act as pioneers in adopting innovations, setting trends that subsequently influence global diffusion and standardization (Beise, 2001, 2004; Beise & Rennings, 2005). Lead markets are an extension of the notion of lead users (von Hippel, 1986, p. 198, 1988), which refers to early users of a product who have distinct needs that will become mainstream in a market in the future.

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BUSINESS FINLAND

The aim of Innovation and Growth Research funded by Business Finland is to find solutions to the global challenges of the Finnish economy and society.

Lead markets shape global diffusion by aligning early demand, regulation, and design.

The lead market concept rests on three hypotheses (Beise, 2001). First, market opportunities vary across countries because each country has a unique market context. Second, certain characteristics of a country's market context, such as advanced user needs and strong international networks, increase the probability that innovation designs adopted in that country will be adopted worldwide. Third, domestic firms are better equipped to perceive the specific needs of their national market context and demand. Hence, domestic companies may benefit from lead markets' characteristics by increasing the probability of developing globally successful designs while minimizing risks associated with focusing overly strongly on narrow regional preferences or regulations.

Importantly, lead markets are not defined only by technological leadership but by their capacity to facilitate the convergence of competing designs into a dominant global standard. They bridge the gap between local preferences and international acceptance, often resolving uncertainties through the demonstration effect, where successful local adoption reduces perceived risks for later adopters (Beise & Rennings, 2005). Lead markets can be seen as "forecasting laboratories", making international latent needs transparent and offering early feedback that helps refine innovations for broader adoption (Beise, 2001).

Historically, the Nordic success in mobile telecommunications (Example A) presents a model example of lead market dynamics. Other examples include Japan as a leader in the silver economy (Storz & Pascha, 2011), Germany in fuel-efficient automobiles (Beise & Rennings, 2004), and Denmark in wind turbines (ibid). These experiences, among others, have led policymakers to consider promoting lead markets as a key approach to driving innovation-driven growth. An early instance of such a policy was the Lead Market Initiative, launched by the European Union in 2008 (Example B).

Example A: The Nordic Mobile Revolution – A Historical Lead Market

The experience in mobile communications shows how coordinated lead markets can turn regional innovation into global competitiveness. In the late 1970s and early 1980s, the Nordic countries shared a common challenge: vast territories, sparse populations, and growing mobility needs that created demand for reliable wireless communication.

Rather than building separate national systems, Nordic governments and industry partners joined forces to develop a common standard – the Nordic Mobile Telephone (NMT) network – followed later by the GSM digital standard. This collaboration created an early, open market where firms could compete and learn within harmonised technical and regulatory frameworks.

Shared standards, interoperability, and intense competition gave the region unique advantages. Early demand and aligned regulation encouraged adoption; open markets accelerated cost reductions and learning; and cross-border coordination ensured that technologies developed in the Nordics were compatible with international needs.

When GSM spread globally, the designs, skills, and business models refined in this Nordic testbed became the foundation for mobile communication worldwide. Finnish and Swedish firms, particularly Nokia and Ericsson, were able to scale rapidly, transforming regional expertise into global leadership.

Lead markets are re-emerging as an approach to align competitiveness with the green transition.

Today, lead markets are experiencing a policy revival as governments seek to align industrial competitiveness with strategic priorities such as the green transition, digital sovereignty, health resilience, and defence readiness. The European Commission's Clean Industrial Deal relies on building lead markets for clean technologies (Georghiou, 2025). Lead markets are viewed to "drive economies of scale, reduce costs, and make sustainable alternatives more accessible" (European Commission 2025, p. 7). Creation of green lead markets in sectors such as automobile manufacturing and steel construction is proposed as a critical approach for decarbonizing energy-intensive industries through leveraging solutions like renewable energy and green hydrogen (Hydrogen Europe, 2025; France Hydrogène 2025; IFIEC, 2025; Makaroff & Beucler, 2025). Responding to the challenges presented in the Draghi (2024) report, the Commission's work programme for 2026 emphasizes the acceleration of efforts that enable European lead markets for clean materials and sustainable products. Beyond Europe, the United States has embedded lead-market logic into the Inflation Reduction Act to stimulate domestic clean-tech deployment, and Japan has announced national demand-pull schemes for green hydrogen (Quitzow & Zabanova, 2025; Mural et al., 2024; Mizuho, 2023).

Example B: EU's Lead Market Initiative

The European Union's Lead Market Initiative (LMI), launched in 2008, was a flagship effort to make Europe a first mover in innovation-driven markets by improving demand-side conditions for new products and services. Inspired by Esko Aho's report Creating an Innovative Europe (2006), the initiative sought to address a persistent weakness in Europe's innovation system – the lack of innovation-friendly markets capable of absorbing and scaling new solutions.

The LMI identified six sectors with both economic and societal significance – eHealth, sustainable construction, protective textiles, recycling, bio-based products, and renewable energy. For each, the European Commission, Member States, and industry developed joint action plans combining regulatory reform, public procurement, standardisation, and complementary support measures. The goal was to remove non-price barriers, align regulations, and stimulate cross-border demand to accelerate the uptake of innovations.

The initiative's evaluation in 2011 (Georghiou, 2011) found that the LMI successfully demonstrated the potential of coordinated demand-side innovation policy and created valuable cross-European networks, particularly in areas like sustainable construction and bio-based products. However, it also noted limited national engagement and the absence of dedicated budgets as constraints.

Despite mixed results, the LMI marked a pivotal shift in EU innovation policy – from primarily supply-side support to a more balanced approach integrating market creation and regulatory alignment. It laid conceptual foundations for later frameworks such as the Innovation Union and Horizon Europe's mission-oriented policies.

The LMI experience shows that developing lead markets requires more than technological strength. It depends on aligning regulation, procurement, and standards to create early, innovation-friendly demand and on coordinated action between public and private actors to turn emerging needs into globally competitive markets.

Lead market policies

Lead markets depend on policy-shaped conditions, not only structural advantages.

The premise of creating a lead market is an innovative design with potential relevance among possible adopters, whether firms, consumers, or public entities. Some lead market elements are primarily driven by conditions that are largely exogenous, meaning they cannot be directly shaped by individual actors. For instance, the overall size of an economy, which significantly influences the local demand of a market, depends on population and GDP. However, other conditions can be considered endogenous, as they can be actively shaped by policies, strategies, and the actions of various stakeholders. Leveraging those conditions to proactively drive market formation is the key task of lead market policy. While the lead market concept applies broadly, green lead markets in particular require stronger policy intervention because environmental value is not automatically reflected in prices, and incumbent market structures tend to suppress sustainable alternatives.

Market formation for environmental innovations as a policy objective

Green lead markets require stronger intervention because environmental value is underpriced.

Markets can be defined as arenas that organize the exchange of products or services between sellers and buyers (Fligstein & Dauter, 2007), and they can be conceptualized as having three dimensions: demand, supply, and institutions (Sarasvathy & Dew, 2005). When companies consider entering established markets, these dimensions can be analysed to assess their business potential with the help of market data. However, when business development takes place in the context of new markets, businesses and entrepreneurs encounter high uncertainty, raising the question of whether existing product categories and forms of exchange are appropriate or if new market structures need to be created. In such situations, demand becomes ambiguous due to unclear consumer preferences (Sarasvathy & Dew, 2005), technology performance remains unpredictable, and product categories lack stability (Moeen et al., 2020). Furthermore, the absence of established institutions to support exchanges adds complexity, leaving entrepreneurs to navigate and possibly create these structures as part of the market formation process (Sarasvathy & Dew, 2005). Sustainable innovations, especially, struggle to access viable markets, despite the availability of options, because economic and institutional dynamics often suppress their diffusion. Market formation, therefore, depends on correcting structural misalignments that currently privilege incumbent, environmentally harmful solutions.

Building on research on market formation and technology diffusion (Boon et al., 2020; Finstad & Andersen, 2023; Kjellberg & Helgesson, 2006; Ottosson et al., 2020; Werner et al., 2022) and our empirical research, we suggest that policy efforts to promote lead market formation for sustainable products and solutions should aim at addressing three types of barriers:

Kommentoinut [VV1]: Olisiko tähän tarpeen liittää maininta, mistä nämä kolme pointtia tulevat? Onko nämä jo meidän hankkeen löydöksiä vai vielä kirjallisuuden referointia?

New markets are characterised by demand ambiguity, technological uncertainty, and weak institutions.

1. ***Market failures in valuing environmental benefits.*** First, markets often fail to recognise and reward environmental value. Environmentally beneficial technologies often appear more expensive because prices omit social and ecological externalities, while the benefits they create are diffuse and long-term. In the early phase of the product lifecycle production costs are high as economies of scale and technological learning have not yet impacted. As a result, private incentives diverge from collective ecological goals. Policy instruments, including carbon pricing, environmental tax reform, green procurement, and targeted subsidies, can narrow this misalignment by internalising externalities, signalling long-term value, and creating predictable demand for sustainable offerings.

2. ***Technological uncertainty and system fragmentation.*** Second, technological uncertainty and system fragmentation inhibit coordinated investment. Sustainable solutions frequently depend on complementary technologies and infrastructures, yet uncertainty around performance trajectories and the absence of dominant designs dilute efforts and spread risk across competing pathways. Co-evolution of technologies, infrastructures, and industrial capabilities – supported through standards, joint road mapping, and mission-oriented investments – is required to accelerate convergence and enable scalable, reliable configurations.

3. ***Undeveloped institutional foundations***. Third, institutional foundations remain underdeveloped. Markets cannot value what they cannot measure. The lack of shared standards, metrics, certification schemes, and governance mechanisms raises transaction costs and undermines trust, preventing environmental attributes from being priced, traded, and verified. Building robust institutional architectures, such as calculative tools, monitoring and certification systems, liability and governance frameworks, provides the legitimacy, transparency, and confidence necessary for environmental value to circulate and anchor new market practices.

In sum, market formation for sustainable innovation is not only about stimulating supply or demand, but about constructing enabling economic, institutional, and infrastructural conditions that allow environmental value to become visible, tradable, and strategically investable at scale.

Lead markets are built through predictable policy mixes, not single instruments.

Key policy instruments

Lead market promotion requires mixes of policy instruments signalling that the market will evolve in a predictable direction. When firms and adopters have confidence in the future prospects, they are more likely to invest, build capability, and scale. Effective instruments, therefore, work in combination along a pathway rather than as isolated measures. Early support encourages experimentation and learning. As solutions mature, expectations must shift from testing to adoption: pilots need a route into procurement pipelines, regulatory approval must adapt in step with technology, and verification tools should make environmental performance visible and trusted. Over time, the focus moves from targeted interventions that focus on specific markets and technologies to open competition once scale and cost curves have improved. The objective of lead market formation adds emphasis to demand-side policy measures, such as public procurement, standardization, and regulation, that shape demand for innovations, complementing traditional supply-side measures, such as R&D subsidies. Below, we highlight the operating logic of four key instruments:

Regulation signals future market direction without prescribing technologies.

Regulation. Regulation establishes the rules and expectations that shape how new solutions enter society. It corrects market failures in valuing environmental benefits by raising baseline performance requirements and internalising externalities. In a lead-market context, the purpose is typically to raise the level of demands that solutions need to fulfil without prescribing specific technologies. Forward-looking and adaptive regulation gives developers and adopters early guidance on what will be required in terms of safety, emissions, integration, or data use, reducing uncertainty and aligning planning horizons. When regulatory pathways keep pace with technological development, innovators can scale responsibly, and investors gain confidence to make financing commitments earlier. Stricter regulations enforced in a smaller region may be later adopted in other countries, providing a competitive advantage to firms that have aligned their offering with the requirements. Carbon pricing, environmental taxes, and emissions trading fall within this category by aligning private incentives with ecological value.

Policy example: FuelEU Maritime (Regulation (EU) 2023/1805) on the use of renewable and low-carbon fuels in maritime transport. The regulation requires ships operating in EU ports to reduce the greenhouse-gas intensity of the energy they use through a series of predictable, gradually tightening steps. It does not prescribe specific technologies but helps build a credible lead market for sustainable maritime fuels.

Procurement creates early demand and reduces adoption risk.

Public procurement. Procurement may address both the market failures in valuing environmental benefits and technological uncertainty by creating credible early demand for sustainable solutions. By acting as an early adopter, the public sector reduces the perceived risks for private buyers and provides reference cases that demonstrate performance in real conditions. Strategic procurement that focuses on lifecycle value and performance outcomes over the lowest upfront cost can allow new solutions to be proven and move down cost curves. This not only accelerates deployment but builds the reference cases, capabilities, and supply-chain maturity that private markets rely on. When procurement is used as a structured pathway from piloting to adoption, it becomes a major lever for converting innovation capacity into industrial competitiveness. Implementing public procurement requires institutional foundations for measuring environmental value. Hence, it may also support the development of new metrics and standards and help test and validate emerging frameworks.

Policy example: Norwegian zero-emission ferry procurement. Through competitive tenders with functional environmental requirements, Norwegian authorities created an early, credible market for battery-electric ferries. The 2011 development contract that led to MV Ampere – the world's first battery electric car ferry – demonstrated feasibility and reduced uncertainty, triggering wider adoption of the technology. Subsequent tenders incorporated zero- and low-emission criteria across coastal ferry routes, making procurement the main driver behind rapid electrification and establishing Norway as a lead market for zero-emission ferries. See also Example C.

Standards turn technical performance into trusted market signals.

Collaborative development of standards and certifications. Developing and implementing shared standards, metrics, and certification systems addresses the barrier of underdeveloped institutional foundations by establishing a setting where industry actors can shape how environmental performance is defined and validated, making the qualities of new solutions visible, measurable, and verifiable. The aim is to develop reliable ways for buyers, financiers, and public authorities to compare performance and environmental impact, reducing costs associated with market transactions. Such institutional tools are public goods in the sense that their benefits extend beyond individual firms and require collective investment, governance, and maintenance – also creating a rationale for policy intervention. Jointly developed or adopted certification and labelling schemes turn technical performance into trusted signals that support purchasing and investment decisions. By enabling credible comparison, standards help early adopters move with confidence and allow new solutions to compete on merit as they scale. Shared standards also support technological convergence by clarifying interfaces, performance thresholds, and testing procedures, reducing fragmentation in emerging systems.

Policy example: Nordic Swan Ecolabel (Nordic Council of Ministers). Public authorities in the Nordic countries jointly fund and coordinate the Nordic Swan Ecolabel, which develops shared criteria, testing rules, and documentation requirements for product groups such as paints, detergents, and building materials. These criteria have repeatedly driven product redesign, for example by pushing paint manufacturers to develop low-VOC (volatile organic compounds) formulations and detergent producers to adopt readily biodegradable surfactants. Through procurement uptake and harmonised Nordic demand, the label has helped scale such environmental innovations and provided frameworks that later informed European ecolabel and product-policy developments.

De-risking early projects can unlock private investment.

Finance and risk-sharing instruments. Financial instruments mitigate risks arising from technological uncertainty and system fragmentation. Innovations often struggle at the point where capital requirements grow, but market certainty remains low: early deployment often requires capital before the market has fully formed. Financial instruments that share risk, such as risk and performance guarantees, concessional loans, and subsidies, can help bridge this gap without crowding out private finance. Their function is to reduce the technical and financial risks of early movers, accelerate project timelines, and shorten the journey from pilot to market scale. These tools may be valuable as temporary arrangements: as markets mature and technologies become cost-competitive, they should be phased out and allow private finance to take over. Used effectively, risk-sharing mechanisms unlock investment rather than replace it, encouraging credible solutions to scale faster.

Policy example: Sweden's Klimatklivet investment support. Klimatklivet provides targeted investment grants to municipalities, regions, companies, and other organizations that reduce the upfront and technology risks of deploying emerging low-carbon solutions. The scheme has supported early commercial installations of innovative technologies such as fast-charging EV networks, biogas production systems, and fossil-free industrial heating solutions. By sharing risk at the first-deployment stage, Klimatklivet has enabled firms to validate new technologies in real operating environments and create domestic reference cases.

Different policy instruments matter at different stages of technology and market maturity.

Table 1: Policy instruments at different innovation process phases

	Research and development	Commercialization and initial adoption	Diffusion and scaling
Financial	• R&D grants and loans • Tax incentives for R&D	• Financial support for demonstrations • Public procurement • Adoption subsidies	• Financial incentives for sustainable products (e.g., tariffs) • Emission trading systems
Normative	• Intellectual property rights (IPR) legislation	• Advanced environmental requirements • Product certification	• Sustainability requirements and targets

		• Environmental permits	
Information	• Foresight • Mission-oriented and challenge-driven R&D	• Standards • Labelling • Guidelines	• Awareness promotion campaigns • Benchmarking initiatives

Application of various policy instruments and combining them into effective policy mixes should be responsive to the maturity of technology and the phase of green transformation (Table 1). In the early stage, triggering the creation of technological variety and knowledge diffusion is essential by providing support to research and development activities. In the commercialization phase, the focus should shift to creating initial demand for the first applications, de-risking uncertain investments, and demonstrating value. In the scaling phase, emphasis moves towards sectoral policies that have the capacity to influence wider market diffusion by means of creating incentives and preconditions for effective market exchanges, providing support to innovative green products to reach price parity with conventional products, and influencing consumer preferences toward broader market adoption.

Lead markets require coordination between innovation, industrial, and sectoral policies.

Increased demand for policy coordination

Innovation policy has traditionally relied on horizontal measures and focused on early-stage activities such as research, development, experimentation, and piloting. These generic, technology-neutral instruments aim to strengthen overall innovation capacity by improving framework conditions and supporting broad research portfolios, with the expectation that markets will take care of diffusion once promising ideas emerge.

Efforts to steer markets or accelerate the uptake of societally desirable solutions, by contrast, have typically been governed by sectoral policies such as energy, mobility, or agriculture. These domains shape infrastructures, performance requirements, and investment priorities, and therefore play a central role in determining which solutions scale and which remain marginal. As a result, the tools that influence commercialisation and adoption have often been institutionally separate from the horizontal instruments that support invention and early development.

Lead market strategies challenge this division. They highlight the need for innovation policy to engage with later phases of commercialization and scaling, where market structures and regulatory signals become critical, and connect innovation policy more closely to vertical approaches that target priority sectors, innovation missions, or societal transitions. Hence, in addition to horizontal policies, there is a need to develop more comprehensive policy mixes that treat invention, innovation, and scaling as part of the same effort. Instead of innovation policy handing off to sectoral policies when solutions are mature enough, both policy domains must advance in parallel, meeting in the middle so that maturing innovations face regulations, market structures, and initial demand that enable them to compete with established solutions and achieve rapid adoption.

Innovation and diffusion must be treated as a continuous policy chain.

Achieving such transitions requires coordination across policy domains. Policymakers responsible for sectoral, innovation, and industrial policies need a shared view of the future in terms of technological development, market dynamics, and changes in the broader policy landscape. Attention must be given to the timing of interventions to support innovation trajectories at each stage of maturity. Example C outlines a successful case of ramping up battery-electric ferries in Norway, driven by effective synergies between innovation policy and transport policy. In practice, various governance arrangements can be implemented to achieve policy coordination. There can be, for instance, inter-ministerial coordination policies for mission-oriented authorities or programme offices. Sweden's Impact Innovation programme is an example of a recent mission-oriented governance arrangement. It is a joint initiative by the Swedish Energy Agency, Formas (a government research council for sustainable development), and the innovation agency Vinnova that covers both industrial R&D and full-scale demonstrations in real environments in selected areas, such as net-zero industry and sustainable public sector reform.

Example C: Norway's electric ferries – a case of vertical policy coordination

Norway's shift to electric ferries shows how R&D support and market-creating policy can reinforce each other. Public R&D and demonstration funding helped Norwegian shipyards, suppliers and energy companies develop battery-electric ferry designs and charging systems. The first modern electric ferry was then piloted on a real route, which proved the technology, built confidence and created a network of committed actors. In parallel, national and regional authorities aligned rules, tenders and infrastructure support: ferry contracts started requiring zero- or low-emission vessels, and funding bodies backed charging systems at ports. This combination of investing in innovation, testing in real-life environments, and then locking in demand through procurement and regulation encouraged firms to invest and scale. The result was rapid diffusion of electric ferries and a new industrial niche rooted in existing maritime capabilities, supported by close coordination between transport authorities, innovation agencies, and industry.

Sources: Bugge et al. 2022; Sæther et al. 2021; Sjøtun, 2019.

Small domestic markets limit learning and scale but EU-wide lead markets are difficult to coordinate.

Towards cross-border lead markets

Determining the geographical scope of a targeted lead market is a key policy choice. Lead markets have originally been discussed at the national level (Beise, 2004). Later, the idea has been extended to cover regional (Losacker & Liefer, 2020) and international levels (e.g., the EU's Lead Market Initiative). The scope of the desired lead market defines which actors, technologies, and institutions must align, how much demand can be mobilised, and how quickly learning cycles can occur. The small size of a specific economy, such as the Finnish economy, can be considered a constraint for lead market formation. A small domestic market means that early adopters, test environments, and reference cases are limited, slowing cost reductions and learning cycles. Lead markets need enough demand, variation, and real-world feedback to refine solutions quickly and demonstrate their competitiveness.

Nordic collaboration offers scale without excessive complexity.

Expanding scope, however, is not a simple task. Broad international lead-market initiatives face higher coordination demands, more heterogeneous preferences, and institutional complexity. The EU Lead Market Initiative demonstrated this trade-off: its ambition to stimulate Europe-wide markets was constrained by the complexity of designing and implementing effective policies (Georghiou, 2011; Example B). It struggled to align national and EU agendas because selected markets did not always match member state priorities, ministries could not easily coordinate across sectors, and roles were unclear. Many national officials reported difficulty in engaging with it because the initiative cut across departmental mandates and lacked clear guidance on expected national actions.

First-mover advantage requires moving faster than EU-wide processes.

In the middle lies the opportunity to collaborate with neighbouring countries to extend the scope of lead markets without increasing complexity to unmanageable levels. Cross-border collaboration with Nordic and Baltic countries is particularly attractive for Finland as these countries share similar institutional traditions, sustainability ambitions, and advanced innovation and industrial capabilities. The mobile communications case (Example A) shows the strength of Nordic collaboration in creating lead markets. When Nordic markets move together, they can create initial scale, reduce fragmentation, and give firms a predictable regional platform to learn, invest, and garner sufficient size before entering broader global markets.

In many technologies and markets, the European Union provides the general direction for market formation by establishing international regulations and market rules for the European market. From the viewpoint of a single country or a cross-border collaboration among neighbouring countries, merely adapting to EU-level developments is insufficient to provide a distinct first-mover position to a single country or Nordic collaboration. The national policy makers have the opportunity to move earlier and more decisively than the EU-wide processes – for example, by setting more stringent regulations or providing fixed duration subsidies – so that local lead markets generate solutions that can first diffuse to the rest of the EU and then globally.

Example D: Green maritime corridors

Green shipping corridors are a promising tool for accelerating maritime decarbonization by enabling routes where ships use alternative fuels and low-carbon technologies (Global Maritime Forum, 2022). The Nordic countries aim to become the world's most integrated and sustainable maritime region by 2030. They are advancing joint initiatives such as the Umeå–Vaasa–Trondheim corridor, which demonstrates multimodal, low-emission transport and real-time emissions tracking (Gabrielii et al., 2024). These efforts are reinforced by EU policies like FuelEU Maritime and the Emissions Trading System, as well as international IMO targets.

However, the success of green corridors requires more than just innovation and funding. It depends on a strong ecosystem and infrastructure, with active involvement from the entire value chain, including shipbuilding, ports, logistics, and customers (Tsvetkova et al., 2025). The Nordic Fuel Transition Roadmap (Slotvik et. al., 2024) claims that progress is slowed by several interconnected factors, such as the high costs of alternative fuels, limited demand for low-emission transport, slow investment and adoption of new fuels, immature technology and safety regulations, and restricted fuel availability and infrastructure. Upgrading port infrastructure for bunkering and onshore power, and rapidly expanding fuel production and distribution, are essential. While programs like the EU's Connecting Europe Facility support refueling infrastructure, broader measures, such as using emissions trading revenues to close the price gap between fossil and renewable fuels, are needed to move beyond isolated pilots. Green shipping corridors aim to address these challenges by increasing demand, ensuring fuel availability, and encouraging investment in supply chains and infrastructure (Slotvik et. al., 2024).

The Nordics benefit from strong engineering, institutional trust, and a tradition of collaboration, but progress relies on aligning shipbuilding, energy, port operations, and digital systems, and sharing risks across the value chain. Green corridors can foster cooperation, but addressing structural barriers requires coordinated investments, harmonized standards, and long-term strategies that support the entire ecosystem.

Cross-border lead markets are expected to work best between countries with shared institutional logics and complementary industrial strengths. Research on regional innovation and market formation shows that such configurations balance two needs: coherence in standards, regulation, and public-sector priorities, which lowers uncertainty; and complementarity in capabilities and infrastructures, which supports learning and specialisation. Markets shape up faster when actors share similar norms and trust, have overlapping but distinct knowledge bases, and operate within coordination structures that enable joint problem-solving. Proximity in these dimensions – not only geography – reduces transaction costs and supports rapid experimentation.

For Finland, the Nordic region offers these conditions. The countries share similarity in their regulatory systems, sustainability goals, and strong public-sector capacities, yet differ in demand conditions, industrial specialisations, and resource pathways. This mix creates favourable settings for cross-border market formation. Effective Nordic cooperation could provide shared regulatory frameworks, aggregated demand, complementary technological strengths, and stronger demonstration effects. In the maritime transport sector, green maritime corridors are a good example of Nordic collaboration that supports the emergence of cross-border ecosystems and early adoption of low-emission power sources (Example D).

Lead markets emerge where policy ambition, demand, and capabilities align.

Identifying potential lead market domains

Creating lead markets is not about selecting particular technologies as targets for policy intervention, but about recognising domains where policy intervention can unlock international first-mover advantages. Lead markets emerge when several favourable conditions coincide: local demand, regulation, and industrial ecosystems align to allow innovations to be tested, refined, and adopted early enough to influence global trajectories. For policymakers, the task is to identify and develop areas where societal goals, industrial capabilities, and market conditions can realistically align to enable both domestic value creation and international diffusion.

Building on the lead-market theory (e.g., Beise 2001, 2004; Losacker & Liefner 2020; Castaldi et al., 2026), we suggest policymakers can assess potential domains through several interrelated dimensions that shape the likelihood of lead-market emergence.

Early lead market potential is anchored in local problems and strengths.

1) Strategic national relevance
Candidates should address core national priorities, such as climate neutrality, digitalization, health and wellbeing, industrial competitiveness, and security. National commitment matters: institutional focus, political continuity, and public legitimacy lower the risk for firms and investors.

2) Strong technological and industrial capabilities
Lead markets are shaped by capable actors who can refine solutions and respond to market feedback. Policy makers should look for existing firm and research strengths, complementary industries and supply chains, market knowledge in related domains, and specialised skills and infrastructure. Capable actors and collaborative ecosystems play a key role in developing and scaling innovations.

Policy ambition and competition shape global relevance.

3) Early domestic demand and pressure for problem-solving
Emerging demand rooted in local conditions (e.g., energy solutions for cold climates, need for maritime decarbonisation due to a long coastline, health data addressing the needs of an ageing population) supports experimentation and rapid learning. Sometimes, countries face specific societal problems before others, giving them an opportunity to shape solutions that can be later adopted internationally.

4) Policy ambition and direction
Lead markets thrive where public goals are ambitious enough to create forward-looking momentum. Clear, outcome-oriented policy targets – such as zero-emission standards or circular-economy requirements – signal long-term direction, mobilising firms and investors to innovate ahead of regulation. Ambitious requirements set for industry can form a regulatory advantage that enables markets to shape up ahead of others.

5) International relevance and transfer potential
Solutions must plausibly travel. Policymakers should ask: Will similar needs exist in other markets at a sufficient scale in the future? Are there conditions that make innovations easily transferable to other markets? Such conditions can be cultural compatibility, open standards, network effects, or close international connections (e.g., multinational corporations) that facilitate the diffusion of designs from the lead market to abroad.

Lead markets require a deliberate, system-level policy approach.

6) Competitive dynamics
Intense competition within lead markets often drives innovation and refinement of technologies. Hence, the degree of domestic competition can contribute to the emergence of winning designs with international potential. An emerging market should have enough competing firms and approaches to drive iteration, balanced with collaboration platforms that avoid fragmentation.

Policy recommendations

Based on these considerations, we propose the following recommendations for policymakers. Our proposal outlines a set of measures for launching green lead market initiatives in Finland. They should be considered as an integrated set that addresses the necessary steps for the systematic application of a lead market approach, rather than standalone measures.

1. **Establish a government-level process for identifying potential lead-market domains**

   Create a structured, recurring process for assessing promising domains where Finland and the Nordics can gain first-mover advantages. Use interactive foresight, involve industry, regulators, researchers, and users, and evaluate domains across the six assessment dimensions outlined above.

   Responsible organizations: Prime Minister's Office, in coordination with relevant sectoral ministries

2. **Support systematic R&D on market formation processes alongside technology development**
   Complement technology-oriented R&D with systematic research and development on the market formation process in selected lead market domains to identify areas for policy intervention. This includes analysing how environmental benefits are valued by the markets, whether technological uncertainty hinders coordinated investments, and to what extent weak standards, metrics, certifications, and other institutional mechanisms complicate market transactions.
   Responsible organizations: Business Finland and other national R&D funding organizations.

Innovation diffusion benefits from demand-side policy, data infrastructure, and cross-border coordination.

3. **Identify coordination arrangements across innovation, industrial, environmental, and sectoral domains**
   Recognize and leverage suitable governance arrangements and forums for sharing knowledge and perspectives, and coordinating between innovation, industrial, environmental, and sectoral policies to ensure that R&D, demonstration, adoption, and scaling can be planned as a coherent chain. The lead market perspective should be used to connect forward-looking innovation policy, implementation-oriented industrial policy, and scaling-oriented environmental policy. Particular attention should be paid to ensuring that decision-making acknowledges both emerging technologies characterised by high uncertainty and mature solutions supported by an established evidence base.
   Responsible organizations: Prime Minister's Office, in coordination with relevant sectoral ministries

4. **Develop sector-specific policy mixes with strong demand-side components**
   Design sector-specific policy mixes tailored to the market dynamics, technology maturity, and evolving EU-level regulatory frameworks of each sector. Move beyond horizontal, one-size-fits-all innovation policy by combining supply-side policies with demand-side instruments such as procurement, standards, and regulation. Focus on measures with limited duration that gradually reduce the cost premium of green products until markets can take off on their own. In clean technology domains where Finland has specific lead market potential, launch targeted demand-side initiatives which anticipate and reinforce upcoming European regulation, emerging standards, and public procurement obligations.
   Responsible organizations: Relevant ministries depending on the lead market domain (e.g., MEAE, ME, MTC, MAF)

5. **Promote the development of green-economy data infrastructure**
   Treat data availability, interoperability, and distributed data-governance tools as critical public goods necessary for market formation, since new markets cannot stabilise without trusted calculative tools, shared metrics, and reliable environmental performance data. Support R&D projects focused on developing and adopting shared data infrastructures, certification systems, and monitoring frameworks that underpin green lead markets and promote the adoption of public procurement requirements that support their adoption. Support companies and value chains in being early adopters of European green economy data infrastructure.

Responsible organizations: Business Finland, relevant sectoral ministries, and public procurement authorities.

6. **Strengthen Nordic collaboration to scale early markets**
   Increase coordination between Nordic countries to create cross-border lead markets with sufficient scale and learning effects. Move beyond small analytical studies: support sizeable joint pilots, aligned regulation, interoperable standards, and coordinated public procurement. Address the funding gap in Nordic collaborations: current Nordic-level projects are of insufficient size for the necessary impact, whereas EU projects risk being geographically too dispersed to contribute to early market formation for green products.
   Responsible organizations: National R&D funders and relevant ministries, in cooperation with Nordic counterparts.

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