European Planning Studies

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ceps20

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To cite this article: Ejike Okonkwo (05 Dec 2024): What type of emerging green path is the Nordic battery industry: importation or new creation?, European Planning Studies, DOI: 10.1080/09654313.2024.2437261

To link to this article: https://doi.org/10.1080/09654313.2024.2437261

Published online: 05 Dec 2024.

EUROPEAN PLANNING STUDIES
https://doi.org/10.1080/09654313.2024.2437261

What type of emerging green path is the Nordic battery industry: importation or new creation?

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ABSTRACT

The battery industry is an emerging green path; nonetheless, ascertaining the variety of emergence, i.e. whether the industry is a new creation or an imported path, requires more insight. This paper relies on Grillitsch and Asheim's typologies of green paths, particularly leveraging the features of path emergence, e.g. non-local firms, un-relatedness, newness, and resources, as a guide for explaining where the industry belongs. By adopting the Nordic battery industry as the empirical context, the paper suggests that the industry combines the features of both varieties based on unique regional conditions. Hence, the path import-creation concept is proposed to describe emerging green industries that exhibit both features. Actors at multilevel can leverage the study to enhance their understanding of the variety of green paths being pursued in the region. Also, the study advances the literature on regional industrial restructuring via new insight for situating the industry within the existing path typologies.

ARTICLE HISTORY
Received 10 July 2024
Revised 7 November 2024
Accepted 26 November 2024

KEYWORDS
Battery industry; green path development; import-creation; Nordic region; regional restructuring

Introduction

Regions restructure their economies to remain viable (Asheim, Isaksen, and Trippl 2019); green path development presents an option for such restructuring and refers to pursuing industrial development on products and services that promote low-carbon energy utilization, energy conservation, and environmental sustainability (Sotarauta et al. 2019). Examples of the various industries where regional restructuring has unfolded include paper and aluminum (Fosse 2014), offshore oil and gas (Steen and Karlsen 2014), furniture (Grillitsch and Sotarauta 2019), forestry and bioeconomy (Jolly, Grillitsch, and Hansen 2020), automotive (Miörner 2020), pulp (Sotarauta, Kurikka, and Kolehmainen 2022). Restructuring in these industries is contingent on actor's agency through their intended actions e.g. coordinating and mobilizing resources (Fløysand et al. 2022; Rypestøl, Kyllingstad, and Martin 2023; Rypestøl et al. 2021; Sotarauta et al. 2019; Sotarauta et al. 2021; Sotarauta and Suvinen 2018; Sotarauta, Kurikka, and Kolehmainen 2022). They also ensure

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

continuous regional economic development by modifying regional assets to overcome the barriers orchestrated by their lock-in effect (Eriksen and Frivold 2023; Firlus, Martin, and Rypestøl 2023). Some of the modifiable assets that support the different typologies of restructuring, such as upgrading, diversification, and emergence (Grillitsch and Asheim 2018), as will be elaborated in the subsequent section include human assets, e.g. skills and competence; natural assets, e.g. land; institutional assets, e.g. rules and regulations; industrial assets, e.g. technology, financial resources; infrastructural and material assets, e.g. machines (Firlus, Martin, and Rypestøl 2023, 271; Trippl et al. 2020).

Studies claim that 'it is often difficult to relate empirical cases to regional typologies of industrial paths' (Grillitsch and Asheim 2018, 1642). Despite the increasing role of the battery industry, considered an emerging green path in accelerating decarbonization via supporting renewable and low-carbon technologies (Löfmarck et al. 2022), there is still no clear distinction between the variety of emergence to categorize the industry. Relating empirical cases, e.g. the battery industry to path emergence typologies, will foster new ways of thinking and advance the region's transformation by reshaping actors' visions and strategies (cf. Trygg and Wenander 2022). This means that reconceptualizing path emergence could be informative and contribute to an apt understanding of the industry among various actors. Firstly, the societal stakeholders will better understand the non-mutual exclusiveness of the emerging industry to existing industrial structures and opportunities. Secondly, understanding the variety where the emerging battery industry falls could boost the strategic planning to foster the industry, knowing that it provides a win-win opportunity as a new creation and an imported path, which could, in turn, influence the discourses and narrative about the industry. This paper advances the understanding of path emergence, a typology in regional industrial restructuring. The core argument herein is that path emergence can be extended further or understood beyond the current framing where green industries fall only within two varieties, i.e. importation and new creation (Grillitsch and Asheim 2018).

On the one hand, the author leverages the Nordic context, which is considered among the leaders in developing facilities for battery production (Löfmarck et al. 2022). The paper specifically focuses on the Nordic battery belt (NBB). This area extends from Western Finland to Northern Norway, the reason being that these areas are unique in terms of their strong cooperation in developing the industry, and this, in a way, has resulted in the simultaneous development in the cluster of Gigafactories which Bridge and Faigen (2022, 3) refer to as 'large-scale facilities for lithium-ion battery production'. Examining three places within the NBB Vaasa, Skellefteå, and Mo I Rana instead of the regions in the Nordics and Europe where green (battery) paths are emerging facilitates in-depth insight in relating the case towards reconceptualizing path emergence. In addition, it enhances the understanding of the industry based on regional peculiarities.

On the other hand, the author adopts Grillitsch and Asheim's features of path emergence, e.g. non-local firms, unrelatedness, newness, and resources, to guide the inspection of where the industry belongs. These features are operationalized in the following ways, starting with non-local firms, which refers to businesses that did not originate or evolve from the Nordic region; instead, their initial operational bases and capital are exogenous to the region. Next is related variety, which is a situation where industries may be diverse in terms of their core focus but share some common attributes, e.g. knowledge, market, and technology, which enables synergies, cooperation, and spillovers

between them; meanwhile, the reverse applies to unrelated variety (cf. Content and Frenken 2016). Newness represents a novel experience within a region viz-a-viz the establishment of an unfamiliar industry that may appear intricate to actors. Lastly, resources are conceptualized two-fold; when viewed from the path importation lens, they refer to transferable or mobile assets such as finance, knowledge, skills, competence, technology, products, and services. This means that extra-regional resources can only take the form of mobile assets. When viewed from the lens of path creation, they refer to transferable, mobile, and immobile assets such as natural assets, e.g. land (cf. Firlus, Martin, and Rypestøl 2023; Trippl et al. 2020).

In light of ascertaining the variety of emergence to categorize the industry, the paper asks the following question: What typology of green path emergence is the battery industry? Before unraveling the distinctions, it is imperative to have a firm grasp of the Nordic battery context by uncovering the preconditions that support its emergence. The rest of the paper is structured in the following order: the Nordic battery context, the typologies of green paths, the research approach, findings based on empirical inspection of the industry and regional context, discussions, and conclusions.

The Nordic battery context

The rise and decline of the region's economy

Several historical events have led to the economic rise and decline in the Nordic region, thus necessitating the emergence of new green industries for economic revival. The rise is attributed to the growth in population due to the advancement in the transport infrastructure, improvement in energy sources, and the growth of extractivism in the twentieth century (Tornieri, Ma, and Rizzo 2024). The decline is tied to the 'technological innovation, overproduction, and the beginning of de-industrialization in the West, triggering a population shift from industrial centers to service ones' (ibid, 1758). These dynamics ushered in the disequilibrated emigration pattern from the Northern to the Southern regions, which remains unabated as most economic opportunities are concentrated in bigger cities (Okonkwo, Berg, and Rabetino 2024). It has been argued that increasing the region's attractiveness and utilizing local resources and renewable energy will strengthen the region's resilience towards its socioeconomic woes in terms of job creation and attraction of talent (Tornieri, Ma, and Rizzo 2024). Besides the economic aspect, the region is also besieged by environmental and climate challenges, which remain a threatening concern leading, for instance, to diminishing ice cover and increased carbon emission in the environment (Morata et al. 2020). Consequently, urban and regional planners must devise a means to mitigate these impediments to the region's economic vitality (Trygg and Wenander 2022).

The battery industry as a remedy to the region's challenges

Regional restructuring presents an opportunity for the region to boost its economy, and this, according to Tornieri, Ma, and Rizzo (2024, 1759), is driven by 'the need for critical minerals and the transition of the extraction industry to a carbon neutral economy is

unleashing a new wave of investments in the north'. Indeed, the emerging battery industry can contribute towards reversing the population decline and the north-to-south emigration patterns orchestrated from the region's economic and historical trajectory. The industry's emergence cut across the entire region, with a recent success story being the commencement of operations of the Morrow battery cell factory in Arendal, in Southern Norway (Morrow Batteries 2023). Several factors make the industry's emergence possible, e.g. as shown in Figure 1, the raw materials are dispersed across geography and provide the critical ingredients for battery production (Adolfsson-Tallqvist et al. 2019; Battery Norway 2023; Viegand 2022). Despite the broad distribution of the industry activities in the region, some areas referred to as the Nordic Battery Belt (NBB), highlighted in blue in Figure 1, have distinguished themselves by the level of cross-regional cooperation leveraging their proximity to advance the exchange of knowledge, ideas, strategies on infrastructure development, and regional branding (Okonkwo 2024; 2022). The NBB is an initiative for cooperation between the regions of Central

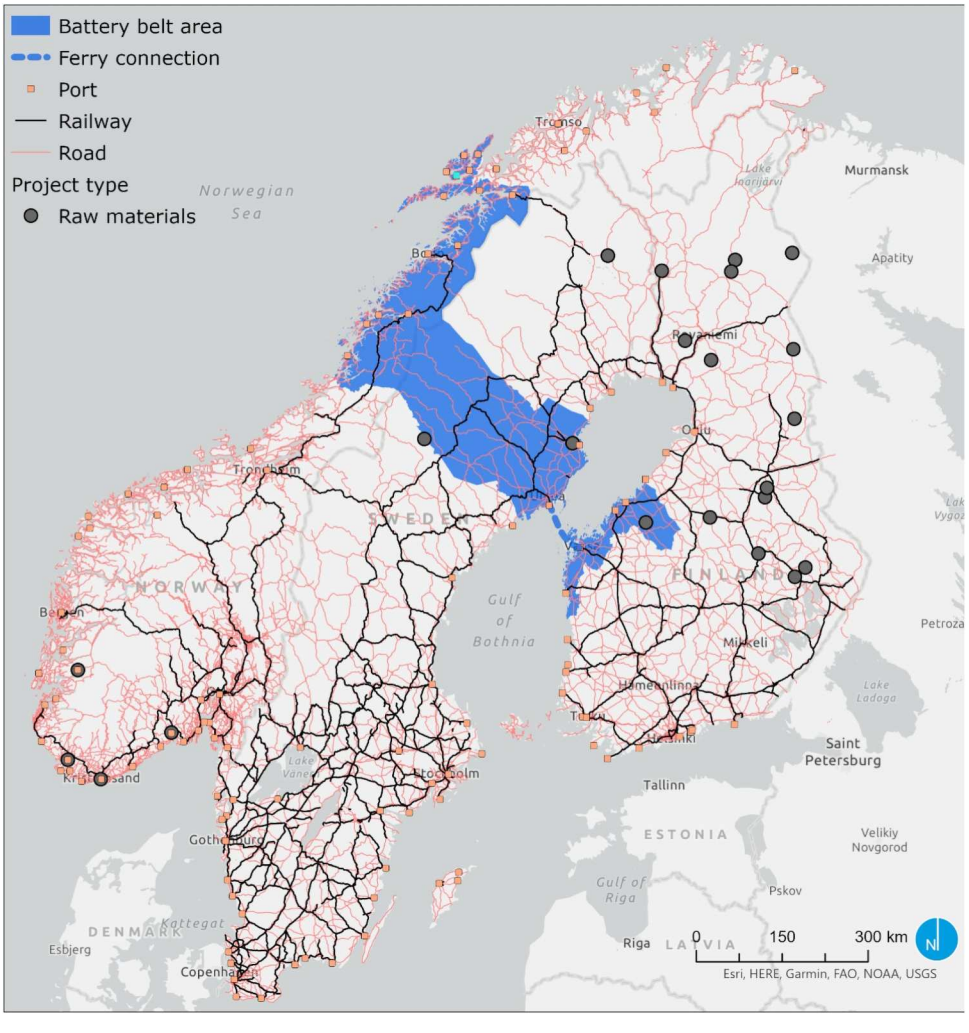

Figure 1. The Nordic battery industry context (Löfmarck et al. 2022, 17).

Ostrobothnia and Ostrobothnia in Finland, Västerbotten County in Sweden, and Nordland County in Norway (Okonkwo 2022).

The role of actors in revitalizing the region's economy

Restructuring the region's economy requires the active involvement of heterogeneous actors operating at multiple levels and their intentional agency. At the national level, actors coordinate and mobilize efforts to accelerate the industry's emergence by developing battery strategies that serve as a road map for different aspects of the industry. For example, solving the human asset challenges that may impede the industry's growth is a significant concern. An insight into actors' investigation on the state of human assets within the Finnish context reveals that skills and competence are 'fragmented and limited, and skilled workforce is deteriorating, especially if new young and international talents are not attracted' (Ministry of Economic Affairs and Employment of Finland 2021, 15). Similar discoveries have been made within the Swedish context, where they have identified that 'access to skilled labour is already a bottleneck for the entire battery value chain' (Fossil Free Sweden 2020, 36). Likewise, Norwegian actors envisage that there will be a 'shortage of skilled workers, which will exacerbate the lack of competencies in volume, specialization, and skills development' (Regjeringen.no 2022, 26). Furthermore, actors within the Finnish context have developed a national action plan for increasing the attraction of the workforce and investors; according to them, this involves improving the region's visibility through branding (Ministry of Economic Affairs and Employment 2021, 25). Similarly, their Norwegian counterpart identifies the need to promote the country as the correct destination for investing in green technologies (Regjeringen.no 2022); likewise, marketing the industry as imperative towards the decarbonization agenda will advance the Swedish battery industry (Fossil Free Sweden 2020).

Furthermore, at the regional level, actors continually engage potential investors in investment discussions towards reaching a mutually beneficial agreement (VASEK 2023). Regional development agencies have also established new networks for strategizing on improving transportation systems, which is envisaged to enhance the supply value chain within the industry (Okonkwo 2022); moreover, new infrastructural projects to enhance the connectivity to industrial sites, e.g. roads are being constructed (Vaasa.fi 2022). Furthermore, regional authorities create opportunity spaces as part of their central role in spurring actions, e.g. by providing a platform that assembles tripartite actors from the public-private sectors and societal stakeholders for promoting knowledge exchanges in the battery development process. A good example is EnergyWeek, an annual conference that is an intellectual space for discussing energy-related topics and the latest ideas (EnergyVaasa 2022). Similarly, the Society Expo 2026 is planned by the Skellefteå municipality to foster discussion on advancing the industry (Renström 2024). Besides, the educational institutions are not left out as they advance battery and other energy knowledge through, e.g. the University of Vaasa Energy Business Innovation Centre (VEBIC) devoted to knowledge co-creation (University of Vaasa 2022).

Actors also engage in cross-border cooperation to mitigate the human asset challenges that could adversely affect emerging green industries (cf. Firlus, Martin, and Rypestøl 2023). As a matter of fact, 'in order to access knowledge and resources through extra-regional networks, it is necessary that the regional actors can identify sources of relevant

knowledge, establish knowledge transfer mechanisms (e.g. collaborations, recruitment), and absorb new knowledge' (Grillitsch and Asheim 2018, 1648). In this regard, actors participate in cross-border cooperation to enhance their agency to solve the human asset challenges in the region. For example, Merinova, a regional development agency, participates in a European initiative known as the Alliance for Batteries Technology, Training, and Skills (ALBATTS), which aims to map out the skills and competence needs of the Nordic battery industry. For example, Merinova gathers intelligence on future job roles and skill sets needed in Stationary and Industrial Battery Applications (ISIBA) (ALBATTS 2023).

Meanwhile, on the firm level, actors are working to ensure that existing competencies in the energy clusters within the region can be reskilled and leveraged for the emerging battery industry (Regjeringen.no 2022). Such reskilling is imperative as a complementary measure to offset the deficiency of competence required for battery production. Likewise, companies are providing necessary support to enhance inter-sectorial cooperation and knowledge co-creation, e.g. Smart Technology Hub (STH) is a recent physical space established by Wärtsilä where actors meet and exchange ideas (Wärtsilä 2024). Beyond that, several companies are directly involved in constructing and operating the Gigafactories, e.g. in the Vaasa region, Finland; there is an expression of interest by a Chinese private firm for the construction of an anode material production plant envisaged to employ 1200 workers at the initial stage (Varjonen 2023). Establishing the plant is capital intensive, amounting to approximately 1.3 billion euros and producing 100,000 tons annually (Niemi 2023). Northvolt in Skelefteå municipality in Sweden, with an employee base of over 3500, has begun the first homegrown gigafactory in over 500,000 square meters. One outstanding aspect of their operations is the reliance on renewable energy sources for their power consumption, which amounts to 360 megawatts, equal to 1.5% of Sweden's total energy production (Northvolt 2024a). Freyr, an indigenous Norwegian battery-producing company, drives the industry in Norway (Adolfsson-Tallqvist et al. 2019, 29). Within the Nordic region, the company has expressed interest in constructing a battery production plant in Vaasa, Finland (VASEK 2023); their operations are domiciled in Mo i Rana, Northern Norway, where it has two magnificent facilities, i.e. the Giga Arctic in Sentraltomta and the Customer Qualification Plant (CQP) located in a 13,000 square meters building consisting of an industrial scale production line, Quality test lab, and tester for life cycle of battery cells (Freyr 2024a). Indeed, firm-led battery innovation has already found its way into the maritime sector where, for instance, the Aurora Bothnia ship, a low carbon-based passenger vessel, leverages on batteries in its operation within the Kvarken Strait (Gulf of Bothnia) that lies between Vaasa, Finland and Umeå, Sweden (Wasaline 2022).

Similarly, the Norwegian maritime sector has increasingly adopted innovations to accelerate decarbonization (Sæther and Moe 2021). The aviation sector is not left out, as it has begun battery-supported technological transitions from carbon to electric-based operations (Okonkwo 2023). Despite the knowledge of the industry and the efforts of actors to advance the sector, the question of what type of green path the battery industry falls under is explicitly not fully addressed, especially since the path typologies of emergence comprising importation and new creation are somewhat similar (Grillitsch and Asheim 2018). Therefore, to determine where the battery industry belongs, insight into the various types of paths is essential as it provides the premises and understanding for situating the industry path belongingness.

The typologies of green path development

A region may adopt different green paths in its economic restructuring process, e.g. path upgrading, diversification, and emergence (Grillitsch and Asheim 2018). Firstly, path upgrading is intended to strengthen the financial position by climbing the global production network (GPN) through niche development and by making changes based on new technologies, innovations, and business ideas (Grillitsch and Asheim 2018; see also Grillitsch and Hansen 2019; Sotarauta et al. 2021). Path diversification entails transitioning industrial operations towards more sustainable products and services (Grillitsch and Asheim 2018). It consists of two components related diversification: a 'firm-level process involving the transfer of resources from an existing industry to a new one' (ibid, 1641). Empirical studies on diversification within the Stavanger region of Norway (Eriksen and Frivold 2023, 28) and within the aviation sector in the Kvarken region (Okonkwo 2023) reveal that resources may also come from related industries. Diversification could also be unrelated, i.e. transferring resources to an unlinked industry. Sotarauta et al. (2021, 94) argue that a regime may leverage diversification to sustain itself by strategically transitioning its activities from a carbon-based to a greener industry; they may do this by leveraging the existing competence within the industry.

Thirdly, path emergence entails the 'setting up of an established industry that is new to a region (e.g. through non-local firms) and unrelated to existing industries in the region' (Grillitsch and Asheim 2018, 1641). Subsequently, it is conceived as 'creating new green industries which do not draw on the knowledge bases of existing regional industries' (Sotarauta et al. 2021, 94). Path emergence is argued to comprise two components, e.g. path importation and new creation (Grillitsch and Asheim 2018). The former relies mainly on exogenous (extra-regional) factors to a region, such as the inflow of human, financial, and technological resources (Grillitsch and Asheim 2018, 1642; MacKinnon et al. 2019, 122; Trippl, Grillitsch, and Isaksen 2018). Indeed, an imported path may represent new experiences for actors within a particular region; in contrast, this may not be the case for other areas, as such a path may have existed over time (Grillitsch and Asheim 2018, 1642). The latter, i.e. new creation, entails establishing a novel path driven by 'new technologies, scientific breakthroughs, or radical innovations based on new business models, user-driven or social innovations' (ibid, 1641).

New path creation is supported by what MacKinnon et al. (2019, 115) refer to as delocking factors, e.g. 'heterogeneity among agents, technologies, institutions, and social networks that foster variety and innovation'. Similarly, Trippl et al. (2020) argue that several systemic factors enable or constrain GPD, including industrial, organizational, and institutional structures. The former provides a favourable environment that facilitates further greening initiatives as it enables the reuse or transfer of existing assets to support a new path; in contrast, a regime, through its policies and actions, may constrain a new path due to its vested interest to protect their investments, thereby resisting change. Meanwhile, financial, educational, and civil society institutions are typical examples of organizational structures that promote GPD; however, in a situation where, e.g. the banking sector and venture capitalists are indisposed to provide the needed financial support, this could impede GPD. Likewise, environmental non-governmental organizations (ENGOs) and social movements may promote GPD, e.g. by supporting restructuring policies by raising awareness of the importance of an emerging path; conversely, based on the prevailing

situation, they may oppose a green initiative. Formal institutional structures manifest through rules and regulations that support the green path; it becomes constraining when they favor nongreen paths, such as brown industries. Non-formal structures are mainly socio-cultural regarding the perception, values, norms, attitudinal and behavioural aspects within the society which may enable GPD, e.g. when people are receptive and disposed towards GPD. Meanwhile, non-formal structures become constraining when societal stakeholders engage in unsustainable practices that adversely affect GPD, e.g. through the consumption patterns that could manifest in patronizing brown industries.

The research approach toward reconceptualizing path emergence

The Variance approach asks the 'what question' and 'seeks to explore and explain relationships between independent and dependent variables, asking research questions about what the antecedents and consequences of some key construct may be' (Payne, Pearson, and Carr 2017, 12; Van de Ven 2007). The case study of the Nordic region is variance-driven to determine what variety of path emergence the battery industry can be related to or categorized based on its attributes influenced by the regional condition where they are domiciled. Path emergence typology is the dependent variable because it is mutable based on the nature of the independent variable, i.e. the battery industry. Put differently, the industry is static, meaning it does not change based on how they are reconceptualized as either a new creation or an importation. Instead, such re-envisioning increases insight into the nature of the industry, such as the contextual factors, e.g. actors, networks, and institutions that drive the energy storage sector. In addition, in the variance approach, there is 'an expectation for explaining (i.e. theorizing) why some variables or constructs are included in the model over others, as well as how they are related' (Payne, Pearson, and Carr 2017, 16). That being the case, the paper's focus is limited to providing a new perspective for understanding path emergence rather than examining all the typologies in regional restructuring.

Consequently, the variables adopted in ascertaining what type of emergence the battery industry belongs to were drawn from Grillitsch and Asheim's (2018) features of path emergence, e.g. non-local firms, unrelatedness, newness, and resources. Before this study, as the literature reveals, there was no clear conceptualization of the type of emergence the battery industry belongs to, which is then considered the antecedent. The consequence of reimagining path emergence variety is that it enhances the understanding of the industry's characteristics among stakeholders. It could also influence actors' agency in strategic planning and fostering the industry's development. One consideration prior to selecting the battery industry as the empirical case is the accessibility and availability of information, e.g. documents and official reports, in line with the claims that when conducting variance-based research, 'careful consideration should be given to data appropriateness and availability prior to moving forward with any research project' (Payne, Pearson, and Carr 2017, 14).

In a nutshell, the discoveries from the typologies

The findings from studies on emergence, which is the core of this paper as summarized in Table 1, suggest that both importation and new creation have similar features, with the main similarity being the novelty in the region where it is emerging and the commonality

Table 1. The features of emergence viz-a-viz the Nordic battery industry context (own Source).

Importation	Contextual underpinning	New Creation	Contextual underpinning
New to the region but not elsewhere	The industry is new in the Nordic region; in contrast to Asian regions, e.g. Japan was one of the pioneers that invested in the lithium-ion battery manufacturing industry, China also has a large share in the battery market with over 88.7GWh lithium-ion batteries production, with the year-on-year growth of 29.3% (Shen and Wang 2019, 2). China is still leading in the industry and expanding its supply value chain (Deberdt 2024). A glance into the Nordic battery context reveals that Northvolt was recently founded in 2016. Their products include Lithium-ion cells, Sodium-ion cells, Lithium-metal cells, Voltpack Core, Voltpack Mobile System, and Voltrack (Northvolt 2024b). Freyr came into being in 2018. They focus on Stationary storage and lithium-ion batteries to support e-mobility (Freyr 2024b). Battery development in the Vaasa region is still in the early planning stages, and the construction of an anode plant is expected to commence soon (Okonkwo 2024).	*Radically new to the region*	The Nordic experience in battery production is entirely new, as such industries were non-existent until recently. The radical shift in developing the battery industry in the region and across Europe began in response to the changes in the Chinese policy in 2016, where new vehicles in the Chinese market must be electric and supported by internationally produced Chinese battery manufacturers within the country. The bill implies a drastic reduction in the demand for carbon-based products manufactured in Europe (Regjeringen.no 2021, 16).
Unrelated to existing industries in the region.	Based on the prevailing industrial structure, e.g. in the Vaasa region, the notion of unrelatedness does not absolutely apply to the battery industry. The Vaasa region is a hub for energy technology clusters that have long existed and provide services related to the energy sector or technological innovation e.g. ABB, Hitachi ABB Power Grids, Danfoss, Yaskawa, and Wärtsilä. The latter services include optimizing energy for a smarter, safer, and more reliable grid (cf. GigaVaasa 2022; Wärtsilä 2024).	*Entirely new industry*	The notion of newness varies based on regional situations and is not necessarily an entirely new experience collectively at the national level. e.g. in terms of functionality viz-a-viz Gigafactory for energy storage, this experience is entirely new in areas such as Vaasa, Skellefteå, and Mo I Rena. Nonetheless, battery experiences are not entirely new in some regions outside these areas where companies have already ventured into battery-related products and services that support energy technologies (Adolfsson-Tallqvist et al. 2019; Business Finland 2024; Morrow Batteries 2023; Randall 2023).
The inflow of external resources into the region.	Reliance on extra-regional factors varies based on regional context. For example, in Skellefteå, Sweden, and Mo I Rana, Norway, local firms drive battery development in contrast to the Vaasa region, where non-local firms dominate. A typical common feature in these regions regarding extra-regional resources is the need for an external workforce to augment the internal albeit declining supply in the region, as highlighted in the ALBATTS project (ALBATTS 2023).	*High-level competencies*	The region has high competence in existing industries that can be reskilled for the emerging battery industry. These include 'extensive experience in the transport and maritime sectors electrification, strong centers of expertise in materials technology, metallurgy, electrochemistry, and industrial processes' (Regjeringen.no 2022, 57).

of preconditions that support its emergence, e.g. knowledge and competence, financial resources, heterogeneous actors. Meanwhile, the main difference is that importation mainly relies on extra-regional resources while new creation can be deduced to rely on external and internal resources.

So, what variety of path emergence is the battery industry?

Scrutinizing the battery industry based on the feature of path importation, i.e. on the claims of 'non-local firms' as the driver of investment, perhaps it can be adjudged that the extent of non-local firms' involvement in driving the emerging battery industry varies based on regional contexts. As stated, firms are considered non-local in this paper and vice versa based on their historical evolution, e.g. where they were founded. For instance, looking at the Vaasa region experience, reports suggest that non-local companies dominate, e.g. a Chinese investor, Shanghai Shanshan, is developing an anode processing plant (Varjonen 2023) while other multinational companies have also expressed interest (VASEK 2023). In contrast, in Skellefteå municipality, Sweden, Northvolt is a local Swedish firm founded by a Swedish investor and his counterpart. Similarly, in Mo I Rana in Nordland County, Norway, Freyr's historical evolution suggests it began as a local Norwegian battery company, formerly known as Freyr AS before it recently got the shareholders' approval in 2023 to become a U.S. company due to its financial struggles (Ohnsman 2023). This paper conceptualizes FREYR as a 'local' Norwegian company; nonetheless, from a broader perspective and based on the current situation, the company has moved beyond being a local to a global enterprise in terms of its shareholding, and it is being listed in the United States Stock Market. Likewise, Northvolt has opened the company to different shareholders who represent extra-regional resources in terms of their financial investment. Therefore, the takeaway is that the extent to which non-local firms drive path emergence varies based on a regional dynamic, as in Norway and Sweden, where their local firms champion the industry's emergence.

Further probing from the (inflow of) resources necessary to support path emergence, taking competence and knowledge as an example, the battery industry could be considered to combine the features of importation and new creation. Take, for instance, in the former, there is a planned reliance on external competence to boost the internal albeit declining workforce, as the national battery strategies have suggested that a significant portion of the human assets will come from outside the region (Fossil Free Sweden 2020; Ministry of Economic Affairs and Employment of Finland 2021; Regjeringen.no 2022). The skilled and competent workforce needs in the region currently stand in the 'ratio between blue- and white-collar workers at 72,5–27,5%; also needed is the knowledge of automation, manufacturing and production processes, data-oriented skills and competence, and digital skills' (ALBATTS 2020, 1). Likewise, looking at the enormous need for a workforce orchestrated due to the radical newness of the industry to the region as outlined in the strategies, the industry could be regarded as a new creation based on this consideration, and actors could take advantage of both the inflow of skilled workforce and the reskilling of existing competence to align with the needs of the emerging battery industry. This entails that competencies in well-established sectors can be upscaled accordingly, leveraging the 'strong technical industrial and academic communities that collaborate with industry' (Regjeringen.no 2022, 57).

The inflow of resources can be hampered by contextual conditions e.g. the transport connectivity that can enhance the inflow or mobility of extra-regional resources, e.g. humans and material are still a challenge (Okonkwo 2022) within regions in the NBB, mainly because these areas are separated by the strait in Kvarken (Westin 2021b) furthermore, the cross-border rail interconnection of these areas is still underdeveloped (cf. Smedberg et al. 2022). A further potential impediment to resource inflow is the unduly long air travel time orchestrated by the state of the aviation industry (cf. Westin 2021b), e.g. 'the time in the air in conventional aircraft is approximately 160 min, adding transfer time to include two aircraft changes at airports, the total travel time could reach 380 min, at an average door-to-door speed of 200 km/h' (Westin 2021a, 3).

Trygg and Wenander (2022, 1986) observe that 'planners can be considered central actors for realizing sustainable development through strategic planning'. A recent report reveals an ongoing initiative by regional actors to mitigate connectivity challenges, e.g. through a regional initiative called Finding Innovations to Accelerate the Implementation of Electric Regional Aviation (FAIR). The project aims to strategize how to enhance electric aviation governance through sustainable alternatives (Okonkwo 2023). The involvement of regional planners in developing such strategies is imperative, mainly due to the lack of global standardized governance for electric aviation, and regions, by default, must fill this gap for the time being (Smedberg et al. 2022). Electric Regional Aviation (ERA) is a 'new fast and clean mode of transportation, with zero emission alternative optimal for small volumes, and serves as a tool for regional accessibility' (Mäntynen, Huhta, and Rantala 2021, 4). Indeed, ERA can reduce travel time as the innovative technology supports 'direct take-off and landing and high flexibility regarding the location of its operational facilities' (Okonwko 2023, 44; Smedberg, Norberg, and Oja 2021; Westin 2021a). Beyond air travel, a cross-regional collaboration between the region of Umeå and Vaasa is aimed at strengthening travel by water, e.g. an environmental RO-PAX Wasaline vessel Aurora Botnia that combines sustainable fuels and batteries has begun operation and will benefit from the newly developed Kvarken Ports estimated to host 650 ships on an annual basis (Vaasa.fi 2024; Wasaline 2020). These infrastructures will improve the connectivity for the inflow of resources within the region and other European regions.

On the claims of 'un-relatedness', looking at the battery industry from the path importation lens, it can be adjudged that the industry is unique in the sense that while it is new to the Nordic region, it is, however, not wholly unrelated to the existing energy industry clusters as most of the incumbent, e.g. in the Vaasa region is energy technology companies such as ABB, Hitachi ABB Power Grids, Danfoss, Yaskawa, and Wärtsilä (Aslani et al. 2013; Giga Vaasa, 2022). Again, the author thinks that the applicability of unrelatedness varies based on regional conditions, as is the case within the Vaasa region. Therefore, because the industry is an energy storage sector and falls within the energy technology industry, perhaps the feature of un-relatedness is not absolute as it is related to the existing industry in the Nordic region. A common feature between the varieties of path emergence, i.e. importation and new creation, is the idea of 'newness' (Grillitsch and Asheim 2018). The battery industry is new and thus combines the features of importation and new creation. For example, on the one hand, it can be considered as an imported path within the Nordic and across many European regions as it is a new

entrepreneurial experience (Löfmarck et al. 2022) when compared, for instance, to the Asian countries where battery production has been ongoing for decades (Bridge and Faigen 2022, 12). On the other hand, it could be seen as a new creation. Even though the industry falls within energy technology, it represents a radical shift from the existing technology clusters in the NBB region regarding the experience in establishing the gigafactory.

To buttress the point on newness from the importation lens, even within a country, the battery development experience differs as some regions already have battery-related industrial activities, making the overall industry experience new to specific regions and not to others. For example, the battery industry experience remains a new phenomenon in the Vaasa region. At the same time, this is not the case in surrounding regions with cell and battery industries. BroadBit Batteries has been in operation since December 2015, focusing on lithium and sodium battery technology, and its headquarters is in Helsinki (Business Finland 2024). Similarly, Valmet Automotive is domiciled in Uusikaupunki, Finland, and deals with battery pack systems for electric vehicles (Adolfsson-Tallqvist et al. 2019). In Norway, while the industry is an entirely new experience, e.g. in Mo I Rena, other regions have relatively more advanced experience e.g. Cenate is in Tomter, southern Norway, its pilot plant is at Holtskogen 45-minute drive from Oslo, the company develops silicon-based materials to replace graphite in lithium-ion batteries, its inaugural anode production was in 2015 (Cenate 2024; Regjeringen.no 2022). Vianode, a company founded in 2016 and domiciled in Kristiansand, southern Norway, produces low-carbon anode graphite solutions; by 2030, they aim to produce 200 000 tonnes of advanced anode graphite to support around 3 million vehicles, with a substantially reduced carbon footprint of 1 kg/kg anode graphite (Regjeringen.no 2022; Vianode n.d). In addition, Morrow Batteries has recently begun operations in Arendal, Southern Norway (Morrow Batteries 2023). When it comes to battery recycling, Akkuser has been in operation since 2006, with its waste battery processing facility in Nivala, North Ostrobothnia; other companies operating outside of the Vaasa region include urecycle Group, Fortum and Tracegrow (Adolfsson-Tallqvist et al. 2019). Recycling also occurs outside of Skellefteå, e.g. Northvolt Labs are domiciled 7 min outside of Västerås city in the southern region of Sweden (Northvolt 2024c). Stena Recycling also has its facility in Halmstad in southern Sweden (Randall 2023).

Conclusions

Relating empirical cases to the industrial path has been a herculean task in regional restructuring literature (Grillitsch and Asheim 2018). This paper reconceptualizes path emergence leveraging the Nordic battery industry empirical context to respond to this concern. It does so by examining the nature of the industry and the regional conditions using Grillitsch and Asheim's features of path emergence, e.g. non-local firms, unrelatedness, newness, and resources. The findings suggest the battery industry combines the features of importation and new creation as they share similar preconditions, such as strong actors and systemic support. Therefore, based on Grillitsch and Asheim's (2018) conceptualization of emergence, one may not be entirely wrong to refer to the battery industry as an imported path or new creation mainly because of the combined features.

Consequently, this paper proposes a new concept, import-creation, to describe emerging green paths that combine emergence features. Considering the region's peculiarities shaped by the prevailing regional conditions, the Nordic battery industry is a good starting point for applying the proposed concept. Indeed, the paper could be relevant for deepening the understanding of regional actors at the forefront of the planning and development process of the battery industry in pursuance of economic vitality. Since planners 'reimagine a possible future of places' (Trygg and Wenander 2022, 1986), the import-creation concept can provide a new lens for reimagining green industries and reshaping how they are perceived among the societal stakeholders, regional planners, and academia. To explicate these points further, starting with the relevance of the import-creation from the societal landscape, a recent study reveals that the lack of understanding of the industry, e.g. among fringe actors such as ordinary citizens, may lead to preference of local dominated investors over foreign investors as the industry is suggestively mainly perceived as an imported path where the dominance of foreign investors could lead to capital repatriation from the region (Okonkwo, Berg, and Rabetino 2024). Reconceptualizing the understanding of the industry as import-creation can reposition stakeholders to realize that the industry is not entirely an imported path where extra-regional resources such as foreign talent will pose a threat to already existing ones. In other words, stakeholders are better informed that the industry is not mutually exclusive to the opportunities of existing industries and talent in the region, but rather equilibrates them. Such understanding will likely reshape and further strengthen societal disposition, attitudes, receptivity, and legitimization of the industry.

Grasping the concept of import-creation among regional planners is equally imperative as they are more informed of the win-win nature of the industry for the existing local firms and the overall region's development. For example, extra-regional resources associated with an imported path, e.g. new technologies, knowledge, and finances, can be leveraged to boost the entire energy technology ecosystem in the region. Similarly, existing firm and system level actors, in turn, contribute to the reskilling of skills and talent that foreign investors can leverage, as already is the case with the involvement of Merinova, Skellefteå municipality, Vamia Vocation Training institution in intelligence gathering on the human asset needs and solutions, e.g. through training and education (ALBATTS 2023). The author thinks that as the battery industry is envisaged to revitalize the once economically thriving region and accelerate the decarbonization efforts, it is imperative that decision-makers can categorize the path emergence typology where the emerging industry belongs. With that the case, actors can easily align their strategies and plans based on this understanding. For example, regional development agencies are saddled with the responsibility for regional branding (Okonkwo 2024). Thus, understanding the import-creation concept could ensure an equilibrated narrative on the industry regarding the win-win economic opportunities it presents based on its combined variety of import-creation.

In sum, this paper examines the battery industry's empirical context and relates the findings for coining a new concept, i.e. import-creation, to underpin a new variety of emergence. Indeed, the paper shows that factors such as the nature of a new green industry and the regional situation where they are domiciled influence the reconceptualization of emergence typologies in the GPD literature. Future studies could compare emerging green paths within a specific regional context to determine if they fall within the new

concept. A taxonomy of paths that solely fall within each variety of emergence could also be developed.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The article is based on secondary data and they can be assessed via the reference section.

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