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The role of clusters in addressing societal challenges in European regions

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ABSTRACT

Clusters can play an important role in helping regions to address transformative innovation policies in Europe focusing mainly on (i) sustainability (ii) smart specialization, promoting diversified specialization and (ii) reshoring/regionalization of value chains to secure economic sustainability and resilience. Clusters can be considered key change agents in aligning cluster policies with transformative policies and repositioning their role in the innovation policy landscape.

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Clusters; innovation policy; societal challenges; regions; smart specialization

1. Introduction

Clusters – or different concepts of agglomeration exploiting external economies of scale – have long been acknowledged as a crucial element in the organization of economic activity for businesses, regions and national economies. However, there is a need to repositioning clusters' role in the innovation policy landscape, especially their role in driving transformative change at the regional level. In this article, we address the question and presents a critical review and discussion of ways clusters can contribute to solve some of the current main challenges for European regions with a focus on:

- (1). Environmental challenges, where climate change is one of the biggest sustainability problems.
- (2). Smart specialization, promoting diversified specialization.
- (3). Reshoring/regionalization of value chains to secure economic sustainability and resilience.

The challenges discussed in this article are aligned with the three recommendations of clusters activities proposed by the EU expert group (EU 2021). The EU expert group suggest that clusters activities should be prioritized towards (a) leading the transition towards a clean, circular and climate-neutral economy, (b) accelerating the digital

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transition and (c) building resilience in their future activities. In this article, we make an additional contribution by linking the discussion closer to recent changes in the geopolitical landscape by focusing on supply chain resilience and security. The concept of agglomeration exploiting external economies of scale, known as localization economies from sector specialized firms, has a long history dating back to Marshall's industrial districts published in 1890. Perroux (1955) further developed the idea with the concept of growth poles. Perroux' concept was relaunched by Porter (1990) talking about national industrial, and regional clusters, and later more and more focusing on regional clusters (Porter 1998). While Marshall's industrial districts were organically grown agglomerations, Perroux had more planned clusters in mind, as his theory was developed as a foundation for the European Steel and Coal Community, a predecessor for the European Economic Community. Porter's theory on clusters does not explicitly differentiate between organic and planned development of clusters, however, his theory has been extensively used, with the help of an international community of consultants, to launch public policies on clusters to promote regional and industrial development. Today, there are more than 3000 clusters in the EU, employing around 50 million people (EU 2021).¹

In this paper, our focus is on planned clusters resulting from policy interventions. We contend that to effectively address societal challenges, it is crucial for clusters to be integrated into national clusters policies that provide long-term funding and requirements of a strong cluster management organization. Furthermore, when clusters have collective leadership, they are arguable more likely to possess the capacity to implement the principle of directionality.

The more conventional cluster policies may arguably fall under what Schot and Steinmueller (2018) refer to as the second framing of innovation policies as systems of innovation.² In this paper, we argue that cluster policies can play an important role in solving societal challenges such as climate change – through what Isaksen, Trippel, and Mayer (2022) call reorientation strategies, i.e. greening of existing activities, shifting the use of existing competences from polluting value chains (e.g. supply to the oil and gas industry) to green value chains (e.g. offshore wind), or by developing new, more sustainable industries within a cluster or between clusters. On the contrary, although clusters policies can contribute to reorientation strategies to address societal challenges, it is important to note that they may not encompass *all* potential transformation strategies that are currently receiving increased attention. The transformative innovation policies – labelled the third framing of innovation policies by Schot and Steinmuller (2018) aims for systemic change and extend beyond the confines of cluster policies.

Ssecond, we argue that clusters can also play an important role in realizing the goals of the Smart Specialization Strategy, which aims to promote diversified specialization through related and unrelated diversification as well as new path creation (Asheim 2019). The Smart Specialization Strategy (S3) has been assigned a central role within the Europe 2020 development agenda by the European Union (EU) to promote smart, inclusive and sustainable growth (European Commission 2012; European Commission, COM 2017, 376). S3 has been updated to include sustainability strategies (S3 to S4) in alignment with the EU's Green Deal (Nakicenovic et al. 2021). Further, it is the cornerstone of regional industrial and innovation policy in the EU and Norway (European

Commission, COM 2017, 376; KMD 2018). Furthermore, it is mandatory for regions to adopt and further develop their S3 strategy to receive Structural Fund.

Clusters have for a long time been part of the policy tools of implementing S3 policies (Belussi and Trippi 2018). However, one remaining challenge to make clusters instrumental to designing and implementing smart specialization strategies has been the shift from the ‘Porterian’ focus on industrial specialization towards a more integrated view of specialization and diversification. A more ‘diversified specialization’ creates the foundation for product differentiation to gain competitive advantage (Asheim, Boschma, and Cooke 2006, 2011; Foray, David, and Hall 2009; Balland et al. 2019) and further builds resilience (Xiao, Boschma and Andersson, 2018; Kitsos, Grabner, and Carrascal-Incera 2023). Still a major problem, especially in peripheral regions in Eastern and Southern Europe with weaker institutional and governance structures, has been to promote the understanding of ‘diversified specialization’. There exist multiple instances where these regions emulate the strategies employed by other regions within the country or neighbouring regions in different countries (Deegan, Broekel, and Fitjar 2021). As a result, they fail to accomplish the main goal of S3 policies of diversifying the region’s strategy from other regions nationally and internationally. This is a basic requirement for achieving innovation-based competitive advantage.

Moreover, the development from S3 to S4 pursuing a direction towards more sustainable and greener industries is a strength (Miedzinski et al. 2021). Here, clusters and their organizations may facilitate the interactions across several value chains and R&D projects directed towards novel strategies of diversification into new markets. Further, public support might also need to consider demand-side issues in order to facilitate the transformation in the right direction.

Thirdly, we argue that clusters can play an important role in repositioning the economies of European regions through the restructuring of global value chains. During the past years, the lack of supply chain security and resilience has been notable. This became evident during the Covid-19 pandemic. Nowadays there is increased attention about the advantages of a regionalized value chain or re- or near-shoring activities (Foroohar 2022). However, while clusters’ role in GVC for a long time has been discussed, with a focus on upgrading potentials of regions (Humphrey and Schmitz 2002; Crestanello and Tattara 2011), the topic of clusters’ role in reshoring strategies has so far received less attention in academic circles. Increased geopolitical risks as illustrated by the war in Ukraine (and a potential future conflict about Taiwan) are adding new issues to the problems of the management of global value chains, in addition to human and labour conditions (slave labour and child labour). A reshoring of production will moreover reduce CO₂ emissions (due to the reduced length of transport and improved cleaner energy and production methods). Thus, environmental as well as social sustainability will be promoted. The Recommendation Report (EU 2021) also focuses on problems of potential disruption in supply and value chains, as part of the third point of building resilience. However, in order to make reshoring strategy economic sustainable and competitive, European clusters need to upgrade their technology by adopting Industry 4.0 strategy, to integrate physical and digital systems. This renders necessary a whole reskilling of the workforce.³ This is also in line with the Recommendation report (EU 2021) when discussing what is needed to accelerate the digital transformation. This means

an alignment of industrial and innovation (cluster) policies with environmental and trade policies.

The paper uses a sample of relevant European clusters located in Norway, Germany, Sweden, the Netherlands, UK and Austria as examples to illustrate our discussion and reflections in an explorative and conceptual direction. We draw upon a diverse range of data sources, including interviews of cluster managers, firms and public authorities,⁴ supplemented by open-access secondary data, online resources and previously conducted research. While the clusters mentioned and discussed in the paper are not comprehensive, they do serve as useful empirical examples of how and why clusters can play a significant role in addressing the challenges European regions face. The selection of the clusters is based on the author's knowledge about the clusters through years of conducted research and available material from different research projects, such as Drivers of regional economic restructuring, Regional Growth Against All Odds (ReGrow) and Regional Resilience and Sustainable Industrial Restructuring (RegReSir).⁵

The paper is organized into three sections starting with the introduction. In the following section, we discuss clusters and regional innovation policies in Europe, using empirical examples of clusters as mentioned above with the focus first on (i) Environmental challenges, (ii) Smart specialization, promoting diversified specialization and (iii) Reshoring/regionalization of value chains. Conclusions and suggestions for future research are presented in the final section.

2. Clusters and regional innovation policies in Europe

Clusters have gained significant attention in policy-making and academic circles (Porter 2003; Uyarra and Ramlogan 2016; Harris 2021, Isaksen, Tripl, and Mayer 2022). In the following sections, we shall discuss how clusters can play a key role in contributing to solving some of the main challenges for European regions.

2.1. Environmental challenges

In this section, we shall focus on environmental challenges as one of the most fundamental sustainability problems in our lifetime that require urgent attention. The inadequacy of current policies has led to a growing consensus for a mission- and purpose-driven policy restructuring of our economy (Bailey et al. 2020; Martin 2021). The European Commission and national levels' policies have embraced this approach inspired by Mazzucato (2017; 2018), and it has further tripled down to the regional level (Giovannini et al. 2020; Martin and Sunley 2020). While this new approach is a step in the right direction, it has drawbacks as it is dominated by top-down 'one-size-fits-all' initiatives with limited knowledge of what is happening 'on the ground' in the regions. To effectively combat environmental challenges, there needs to be a connection between top-down initiatives and bottom-up approaches, and clusters can play a crucial role in achieving this (Bours, Wanzenböck, and Frenken 2022; von Wirth et al. 2019; Tödting et al. 2022).

As we stated in the introduction, we argue that clusters can play a role in combating environmental challenges by reorientation strategies (Isaksen, Tripl, and Mayer 2022), which means that they can reuse their existing competences and technologies to move

into the direction of manufacturing products and equipment which become part of sustainable value chains. In this way, clusters can play an important role in the response to grand societal challenges. In general, clusters are under increasing pressure to reduce their greenhouse emissions. Examples of such reorientation strategies would be Norwegian clusters that are producing equipment for the oil and gas industry which are now diversifying into new markets by producing platforms for offshore wind farms and facilities for offshore fish farming, as well as maritime clusters diversifying from building supply ships for oil and gas to supply ships for offshore wind and fish farming thus, becoming part of sustainable value chains. In this context, it is important to remember that such clusters are constituted by engineering, synthetic knowledge-based firms, which are not by themselves especially polluting industries. The by far most polluting part of the oil and gas value chain is when the oil is pumped out of the ground and used by consumers and industries.

While most innovations require considerable time to adapt and diffuse, innovation for environmental purposes has in addition risks and costs borne by the inventors while the benefits (e.g. less pollution) are reaped by the society. Therefore, green innovation and technology changes require policy interventions, such as pilot studies, subsidized markets or R&D support that drive the change (Smith and Raven 2012). One example would be the Ampere ferry project in Norway (Steen et al., 2019; Sjøtun 2019). Public support, including procurement policies from local and state authorities, played a key role in driving this change and establishing a new niche for maritime batteries. The Ampere ferry project has shown to be quite effective in the shift to environmentally friendly technologies.

Further, energy-intensive sectors, such as chemical, iron, steel, cement and aluminium have until now been sheltered from strict energy and climate policies over the concern of potential job losses (mostly in peripheral regions), and national competitiveness. Moving towards environmentally sustainable practices will require investment in technologies that decarbonize their production, e.g. through carbon capture and storage (CCS). These technologies are expensive but can become more feasible when implemented in clusters where different but related industries can operate in close proximity (Geels, Sovacool, and Iskandarova 2023). Examples of such clusters' initiatives are found in Denmark, Norway, the Netherlands and UK.⁶ However, it is important to be aware that this type of projects can also lead to unintended consequences and institutional change when it is the public procurement actors that create the demands for the firms operating in the market (Krueger 1974; Stiglitz 2015, p. 32; Mazzucato and Semieniuk 2017). Moreover, it can further lead to less efficient and effective procurement outcomes than what was intended, often highlighted as governance failures. It is therefore important to avoid this type of behaviour, especially where there is general low quality of the local institutions (Farole, Rodríguez-Pose, and Storper 2011; Rodríguez-Pose and Garcilazo 2015).

The majority of industries in European clusters are hardware industries producing tangible products, and many of them are embedding digital technology into manufacturing. One example of such a cluster is the regional deeptech cluster in and around Eindhoven in the Netherlands, which is the result of spin-offs of Philips outsourcing some of their non-core activities. Eindhoven Technical University also played an important role in the development of the cluster by educating engineers (Romme 2022). An important

firm in this cluster is ASML, which is the world leader in delivering hardware and software to mass produce patterns on silicon through lithography, making it possible for TSMC⁷ in Taiwan to manufacture the most advanced chips for semiconductors that can be used in green economy activities. A green economy needs a lot of tangible constructions and products (windmills, grids, batteries, EVs, semiconductors), and other types of infrastructure to function, and the existing engineering-based industries in clusters represent a cornerstone in manufacturing such equipment. This demonstrates that clusters can play a significant role in contributing to transformative change by diversifying into more sustainable industries.

Clusters can also be the base for new sustainable industries such as renewable energy. Norway has many new, emerging clusters focusing on onshore and offshore wind and hydrogen energies such as The Norwegian Wind Cluster and the Ocean Hyway Cluster. This cluster is a leading hydrogen cluster with companies in the maritime sector, of which almost all had their main activities supporting the oil and gas sector and now aiming towards diversification and to be part of the hydrogen value chain. One other example is the national competence cluster in Germany, ExcellBattMat, which is formed through a collaboration among four regional cluster partners in Dresden, Munich, Münster and Ulm, and coordinated by the MEET Battery Research Center at the University of Münster.

Thus, existing clusters can be an important instrument of the green transition as well as the establishment of new clusters for developing and manufacturing products and equipment for renewable energy. This is easier to achieve in countries such as Norway, Sweden and Austria that have organized cluster policies in the form of national cluster programs (for example, Innovation Norway and VINNOVA), with long-term funding of clusters (up to more than 10 years), and which require strong cluster management organizations to get and retain funding. Thus, without long-term funding of clusters, most firms would hesitate to take on the new challenges. Norway has a state-supported cluster program known as the Norwegian Innovation Cluster Program. This program was first initiated in the year 2002 and has since then supported around 100 different clusters that vary in terms of sectoral scope, maturity and degree of global competitiveness. The Norwegian Innovation Cluster Program is designed to help Norwegian companies develop and grow through increased collaboration and knowledge sharing. The cluster program operates with three different levels, referring to the age and maturity of the clusters: Arena (emergent clusters), Arena + and Global Centres of Excellence, which denote clusters with a global impact. In the context of industries that are well-established and embedded, there are many examples of emerging clusters that aim for promoting sustainable and diversified industry development. Austria also has a national cluster program, National Cluster Platform, established in 2008 by the Ministry of Economics and Labour (OECD 2022).

Concerning the alignment with transformative policies, in Sweden cluster policies are aligned with transformative policies of VINNOVA such as the Strategic Innovation Program (SIP). In Norway Innovation Norway established a specific national cluster, the Norwegian Hydrogen Cluster (H₂ cluster, an Arena cluster), to coordinate clusters that were interested in hydrogen to promote Norwegian hydrogen clusters internationally.

2.2. Smart specialization, promoting diversified specialization

Over the past decade, the European Commission (EU) has introduced place-based strategies in policy-making, through its Smart Specialization Strategy (S3), promoting the economic transformation of the European regions based on local capabilities and competitive strengths (Foray & Lundvall, 2009; McCann and Ortega-Argilés 2015; Tripl, Asheim, and Miorner 2016). The main idea behind the S3 was to avoid ‘a one-size-fits-all’ approach to territorial industrial development (Tödtling and Tripl 2005). Today, missions’ approach is already adapted by the EU Regional Policy S3 – S4 framework (McCann and Soete 2020). The purpose of Smart Specialization (S4) is no longer diversification or new path development in itself but ensuring a more sustainable and inclusive development path within a global perspective of the UN Sustainable Development Goals (Fitjar, Benneworth, and Asheim 2019; McCann and Soete 2020).

Clusters are seen as important building blocks for implementing smart specialization policies (Koschatzky 2014; Saha et al. 2018; Nilsen and Njøs 2022). However, clusters and policies supporting them have not been as efficient as they could have been due to a lack of understanding of the importance to change the perspective from a traditional industrial specialization to a diversified specialization. In doing so, clusters can be instrumental in diversifying individual regional clusters from other clusters nationally and internationally. Thus, they can improve their competitiveness and innovativeness by diversifying into new industrial path development through related and unrelated diversification. Related diversification can take place through regional branching (Balland et al. 2019), when existing cluster firms use their knowledge and technological capabilities to diversify into new sectors where these resources can be exploited, e.g. when firms building platforms for oil and gas drilling starts constructing platforms for offshore wind farms. Unrelated diversification can be realized when firms use new knowledge (e.g. biotechnology) to diversify and become more technological advanced and competitive in the same sector (e.g. functional food), when firms use existing knowledge (e.g. composite material) to diversify to a new sector (e.g. from ski to aviation) (Grillitsch, Asheim, and Tripl 2018; Asheim 2019; Asheim and Herstad 2021), or through cross-specialization between firms in different clusters (Janssen and Frenken 2019).

In the maritime sector in Norway, one finds examples of complete and highly competitive regional clusters with a broad range of actors, including shipowners, yards, designers, equipment suppliers and knowledge-intensive business services (Mellbye et al. 2016; Grillitsch, Asheim, and Nielsen 2021). The clusters are supported by research institutes and universities in regional and national innovation systems. Such clusters have a huge potential of promoting related and unrelated diversification to change into more sustainable industrial path development, as mentioned earlier. In the same region⁸ in Norway, where the maritime cluster is located, there is also a marine cluster, which, as the maritime cluster, is part of the Innovation Norway cluster program, and the regional S3 strategy pointed at the potential of diversification through cross-fertilization between the two clusters, which is a key aspect of cluster policies to promote diversified specialization.

Innovation studies have long recognized the role of various types of complementarities and feedback mechanisms that drive innovation (Kline and Rosenberg, 1986; Arthur

1988; Dosi 1990), and are important factors in achieving a successful diversified specialization through related and unrelated diversification as well as new path creation (Asheim 2019). Complementarities are crucial for innovation, development and diffusion if the value of a combination of specific elements or assets is greater than the sum of the value of each individual element (Haus-Reve, Fitjar, and Rodríguez-Pose 2019). Such complementarities may be found within the value chain – that span industry boundaries – which means different actors, knowledge bases and business models being involved in the process or between clusters (Mäkitie et al. 2022). These mechanisms are not only important in the phase of developing existing cluster structures, but also in early stages of innovation and diversification processes (Balland et al. 2019). Start-ups and spin-offs are important for regions to achieve diversification (Boschma, 2017). Furthermore, clusters can be of strategic importance in this context by facilitating for large firms in the clusters to support start-ups and spinoffs through being first customer and further open their international network to the new cluster firms (Ferreira, Tavares, and Hesterly 2006).

2.3 . Reshoring/regionalization of value chains

With the Global Financial Crisis and the collapse of the Washington consensus of neo-liberal globalization, GVCs have started to be challenged (Gereffi 2014). Furthermore, given the recent events, such as the COVID-19 pandemic and the changes in the geopolitical landscape, the need for stressing supply chain resilience and security above cost and efficiency has become crucial. Additionally, the urgent need for securing sustainable production, including reducing CO₂ emissions and prioritizing working conditions and human rights, highlights the importance of having supply chains closer to the end market. To achieve this aim, regional clusters can again play a significant role (Grillitsch and Asheim 2023).

The widely globalized system of production and trade that has been dominating the world since the 1970s appears not compatible to the modern societies' needs of sustainability and resilience. On the contrary, a continued globalization driven by transnational companies' (TNC) focused on lowering cost, will only increase the problems. However, the costs faced by local communities have never been taken into consideration by policy makers (Pegoraro, Propriis, and Chidlow 2020).

Another important element that must be taken into consideration in our discussion is the distinction between internationalization and globalization. Internationalization is a result of international trade between countries based on the principle of comparative advantage, while globalization refers to a functional integration of production on a global scale, orchestrated by TNC (Dicken 2015). While internationalization has existed since the sixteenth century, globalization first appeared in the 1970s and was facilitated by technological developments in logistics and communication technologies. Moreover, the new political move towards a de-globalization and reshoring of value chains, especially for strategic products such as semiconductors and vaccines, does not necessarily imply a protectionist trade policy, but a return to a state of internationalization and international trade. While the weakness of the global system has become more evident during the pandemic, further propelled by the war in Ukraine starting in 2022, we saw the drawback of the system becoming more evident also during the 2008/2009

financial crash, and through a more widely increased use of protection of own value chain e.g. the American protection under the Trump's administration period and now by Biden's new strategic industrial and trade policy prohibiting exports of strategic technologies to China. These supply chain disruptions have highlighted the challenges of maintaining connections around the globe. Further, the urgent need for reducing the environmental footprint in production and setting the direction towards a more sustainable production – with a focus on CO₂ emissions, working conditions and human rights, as well as on geopolitical risk factors, all draw attention towards the potential positive impact of reshoring own production capabilities and capacity to achieve supply chain security.

We would argue that clusters, with their embedded knowledge and infrastructure, may play a significant role in taking advantage of the new opportunities for regions that arise from the global challenges and in fostering regional resilience (IMF 2022). In many ways regional clusters represent a meso-level example of GPNs with their horizontal linkages between suppliers and client firms and their vertical linkages between subcontractors and suppliers and client firms, as is found in the maritime cluster in Sunnmøre, which has a complete regional value chain (Grillitsch, Asheim, and Nielsen 2021) or in a traditional industrial district in Third Italy (Asheim 2000). However, clusters are also parts of GPNs/GVCs and in GPNs/GVCs of strategic products (e.g. semiconductors or pharmaceuticals) or with a too high dependence on certain countries, clusters in Europe will have to refocus to see if this collaboration in GPNs/GVCs can be replaced by collaboration within and between regional clusters, in national industrial clusters or between clusters at a European scale.

In this process of production reshoring there is, in fact, a need to upgrade clusters by adopting Industry 4.0 technology for automation, digitalization and robotization (Perez 1983; Capello and Lenzi 2022; Grillitsch and Asheim 2023). The higher the regional specialization in sectors with a rapid adoption of industry 4.0 technologies is, the larger the impact on regional economic growth. One example of a systematic effort of upgrading clusters with 4.0 technology can be found in Austria, which in 2015 established Platform Industry 4.0 as a membership-based non-profit organization by the Ministry for Transport, Innovation and Technology, and a number of stakeholders from industry and worker organizations. The core mandate of the platform was to facilitate the implementation of Industry 4.0 and to foster collaboration among relevant stakeholders with the aim of creating an innovative industrial production sector and boosting high-quality employment (OECD 2022).

To succeed with a regionalization of value chains, especially in an EU context, certain policy and framework conditions have to be in place. This means changes in policies and institutions not only at the local level, but also that an orchestrated set of policies should be implemented at the EU level. First, EU must introduce conditionalities about CO₂ emissions, which the EU has started on by introducing a CO₂ emission-based tariff policy, and by introducing sanctions on trade with Russia in connection with the war in Ukraine. Secondly, national policies must be introduced in correspondence with EU policy on these areas to secure that it is European regions which benefit. Also, with respect to subsidies to renewable investments, e.g. in energy (wind power, solar and battery) and mobility (EV), as well as in the manufacturing of products of strategic importance, such as semiconductors, it is important that national policies are in alignment with EU policies to balance the heavy subsidies on such products launched by

the US, in order to level the playing field and ensure the same competitiveness of firms globally in accordance with the rules of international trade. The challenge for a reshoring policy is to secure a more sustainable and just production that focuses on all sustainability challenges (Grillitsch and Asheim 2023).

3. Discussion and conclusions

This article discusses the important role of clusters in driving transformative innovative changes focusing on three current challenges that European regions are facing, (i) Environmental challenges, (ii) regional diversification through smart specialization strategies and (iii) reshoring/regionalization of value chains. We make three main arguments that partly advance and partly clarify the discussion of the future role of clusters in addressing societal challenges in European regions.

Firstly, we argue that clusters, through reorientation strategies, can play a vital role in helping regions address ‘grand challenges’, such as environmental challenges (Amanatidou et al. 2014). We argue that even if clusters are not considered as primary policy instrument to achieve transformative changes – as cluster policy belongs to the second framing of innovation policy – it is important to provide a direction for clusters to develop a more sustainable industrial diversification. We maintain that this can be achieved by aligning cluster policies with transformative policies as this will connect the top-down initiative of mission- and purpose-driven policies and bottom-up approaches.

The tacit nature of much knowledge means that geography and location play a critical role in the emergence, knowledge sharing and evolution of technology and industries (Maskell and Malmberg 1999; Balland and Rigby 2017), and clusters in European regions can play an important role in ensuring this. Thus, clusters need to reposition their role in a constantly evolving innovation policy landscape and must be considered within the context of a broader innovation system and new emerging transformative policies. We argue that this is easier to achieve if clusters are part of national cluster policies. Such national cluster programs can be found in many European countries, e.g. Norway, Sweden, Austria, Germany and France. In addition to the national cluster programs, European regions can also leverage existing policies through reorientation strategies to align with current challenges and priorities in designing and implementing their S4 strategies to increase the competitiveness of European clusters and drive a sustainable and inclusive economic development in the long-term.

Secondly, we argue that while clusters are recognized as one of the key actors in the implementation of the EU Smart Specialization policy, to be relevant in promoting a sustainable transition of industries, clusters need to reorient and enlarge their focus to include S4- strategies and missions. An important aspect of doing this is to consistently argue that smart specialization aims to achieve a diversified specialization that makes regions unique in relation to other regions nationally and internationally. This is still a remaining challenge especially in more peripheral regions with weak institutions and governance structures and a modest innovation capacity. The lack of understanding of the aim of diversified specialization being different from industrial specialization of traditional cluster policies is an illustration of new policies such as S3 being perceived as just a relabelling of former policies due to policy path dependence, cognitive lock-ins, and lack of new narratives among policy makers.

Lastly, we highlight the challenges faced by supply chain disruptions – particularly in light of recent events, such as the Covid-19 pandemic and change in the geopolitical landscape, which have reinforced a new discussion of reshoring and supply chain resilience and security. Additionally, the urgent need for securing a sustainable production, including reducing CO₂ emissions and prioritizing working conditions and human rights, highlights the importance of having supply chains closer to the end market. To this end, clusters, with their embedded knowledge and infrastructure, may play a significant role in taking advantage of the new opportunities for regions that arise from the global challenges and in fostering regional resilience. In this process of production reshoring there is a need to upgrade clusters by adopting Industry 4.0 technology for automation, digitalization and robotization (Grillitsch and Asheim 2023).

To ensure a successful reshoring/regionalization of value chains, specific policies and framework conditions are essential, such as policy and institutional changes at the local, national and EU levels. Furthermore, alignment with EU policies on CO₂ emissions, subsidies for renewable investments and strategic products is crucial. In the post-neoliberal era the world has entered, it is now possible to put industrial policy on the political agenda and to see industrial and innovation policy in close connection. Moreover, in this context, it is also important to note the alignment of innovation, industrial, trade and security policy that now are promoted in the US and EU.

In this article, we choose to focus on three of the challenges that European regions are facing, and how clusters can reposition their role to help solving them to achieve long-term transformative changes. While our selected challenges may not encompass all potential obstacles, they do align with the three recommended cluster activities identified by the EU expert group (EU 2021). Our article contributes by adding theoretical approaches and links to recent changes in the world economy that significantly has provided a need for new narratives and understanding of the role of clusters in addressing societal challenges in European regions. Given the right renewal of cluster policies and clusters' role as change agents in regions, clusters can play an important role in solving the current challenges of European regions and continue to be a key building block for regional innovation policy.

Notes

1. In this paper, we use national industrial clusters and regional clusters as examples in accordance with Porter's original definition from 1990, building on Perroux' work. Our choice to focus on these definitions is influenced by the observation that the majority of cluster programs initiated by policy in Europe are on a national scale. For established, traditional industries, like the automotive sector, we often find national clusters that are essentially combinations of regional clusters. An example can be seen in the automotive clusters of both Lower and Upper Austria. In contrast, for emerging industries, especially those in new energy sectors such as hydrogen (which requires significant capital investment), the clusters are more nationally focused. A key criterion for being recognized as a cluster in these emerging industries is membership in a national cluster program, like the Norwegian Innovation Clusters. As cluster as a term is of great semantic ambiguity, we adopt and accept a loose terminology definition as Belussi 2015.
2. Clusters are different from regional innovation systems. While clusters are co-located industrial agglomerations with similar or related industries, regional innovation systems consist of two subsystem of knowledge exploration and exploitation, as well as supporting

institutions and organisations. Clusters typically represent the knowledge exploitation subsystem, while regional innovation systems can facilitate several such exploitation subsystems spanning different sectors of industry within a region.

3. Industry 4.0 refers to the fourth revolution that has taken place in the manufacturing sector, characterised by automation and the growth of smart, autonomous systems in the factories, facilitating the use of big data and machine learning.
4. The interviews serve mainly as a source for the empirical clusters located in Norway and Sweden and was conducted as part for the Swedish Finnish-Norwegian research project 'Regional Growth Against All Odds (ReGrow) in the period 2018–20.
5. Regional Growth Against All Odds (ReGrow) was supported by the Länsförsäkringar Alliance Research Foundation of Sweden [grant number 2017/01/011], and Regional Resilience and Sustainable Industrial Restructuring (RegReSir) funded by Regional Research Fund, Vestland and Research Council of Norway [project number 316539].
6. Norway has a national cluster programme, Norwegian Innovation Clusters run by the Research Council of Norway, Innovation Norway and SIVA. In Denmark the Ministry of Industry, Business and Financial Affairs has established national clusters in industrial strongholds, e.g. in the energy sector due to its strength in wind power. Some of these national clusters are constituted by regional clusters as e.g. in Advanced Production with the Odense Robotic cluster. In the Netherlands it is the regional cluster, Food Valley NL, with Wageningen University & Research as the hub, that is also the Dutch national cluster in the food industry, while in the UK it is the CBI (Confederation of British Industry), that initiates regional clusters. Thus, while in most countries it is public authorities that are responsible for cluster programmes and cluster formation, in the UK it is a private business organisation, with public support, that has the main responsibility, reflecting the liberal market economy of the UK (OECD 2022).
7. TSMC is one of the world's largest companies in the production of semiconductors, which are important components in many electronic devices.
8. Sunnmøre is in Møre and Romsdal county. The location resides between the cities of Bergen and Trondheim.

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