



INDUSTRY 4.0

A Policy Brief from the Policy Learning Platform on
Research and innovation

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**Interreg
Europe**



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Summary

Industry 4.0 is redefining the industrial sector thanks to the adoption of new digital technologies, new materials, and new processes. For policymakers, the concept of Industry 4.0 is at the top of their agendas as it could spur huge productivity gains, redefine the whole industrial production model and also potentially have a major impact on manufacturing employment. The European Commission is implementing ambitious industrial policies to address many policy challenges hindering the diffusion of Industry 4.0 technologies such as the low adoption rate from SMEs and increased competition from outside the European Union. In this novel industrial paradigm, regions are ideal spaces for policy experimentation and Interreg Europe projects provide an opportunity for interregional policy learning. This policy brief features six policy recommendations using the experience of Interreg Europe projects dealing with Industry 4.0 to offer regions relevant lessons to enrich their own transformative efforts.

1. From Industry 1.0 to Industry 4.0

The economy has been going through successive industrial revolutions (see Figure 1). The drivers for industrial revolutions are **General Purpose Technologies (GPT)**, which are technologies—such as the electricity or information and communication technologies (ICT)—that are pervasive and spread to many sectors, have a high rate of improvement, make it easier to invent or produce other innovations, and affect the entire economy.

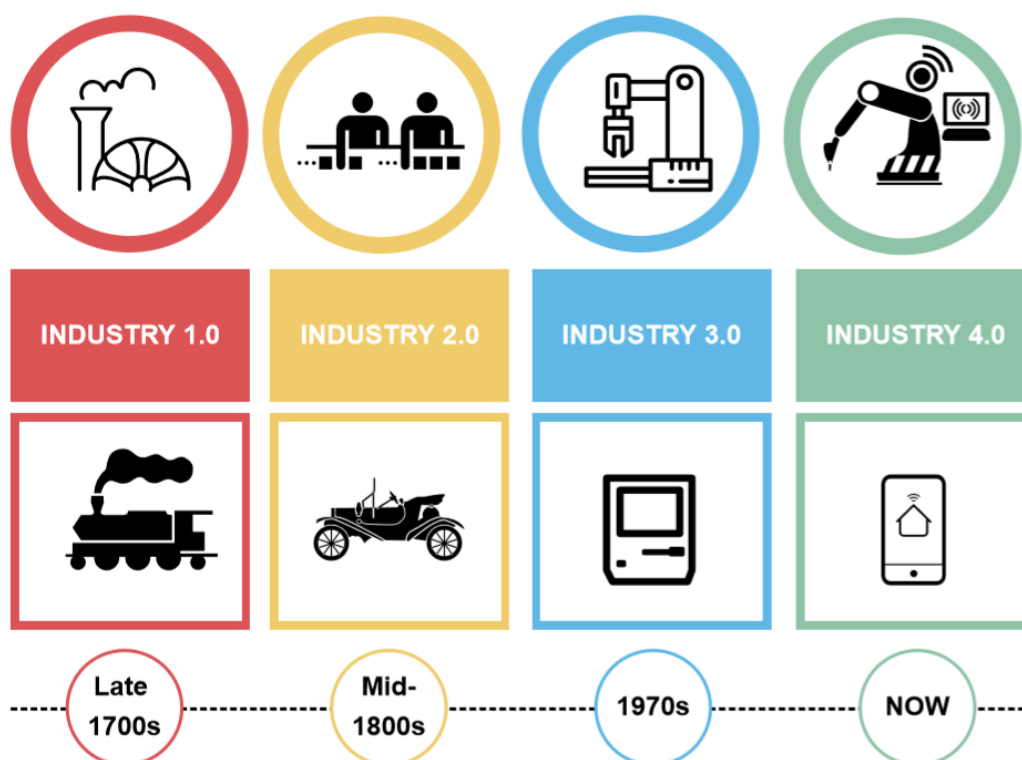


Figure 1. The Four Industrial Revolutions. Source: the authors using infogram.com.

The first industrial revolution, which spanned from 1750 to 1830, was triggered by the invention of the steam engine and railroads. **The second industrial revolution, which lasted from 1870 to 1900,** made mass-production possible with the invention and use of electricity, internal combustion engine, running water, indoor toilets, communications, entertainment, chemicals, and petroleum. **The third industrial revolution, which began in the 1960s,** was



centred around the diffusion of microelectronics, building on the sequential discoveries of the transistor (1947), the integrated circuit (1957), the planar process (1959), the semiconductors (1960s), the microprocessor (1971), the personal computers (1970s and 1980s), the Internet (1990s), and smartphones (2000s). We are now at the advent of **the fourth industrial revolution or Industry 4.0**. The fourth industrial revolution is “**characterized by a much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning**” ([Schwab, 2016](#), p. 7).

2. What is Industry 4.0?

Industry 4.0 implies the adoption in the industrial sector of technologies that have emerged and diffused in recent years (see Figure 2). It ranges from a variety of **digital technologies** such as 3D printing, the Internet of Things (IoT), and advanced robotics, to **new materials** such as bio- or nano-based, to **new processes** such as data-driven production, cybersecurity, artificial intelligence (AI) and synthetic biology ([OECD, 2017](#)). **Industry 4.0** does not only involve the adoption of new technologies but also the adoption of the right skills, know-how, and organisational forms to fully exploit those new technologies.

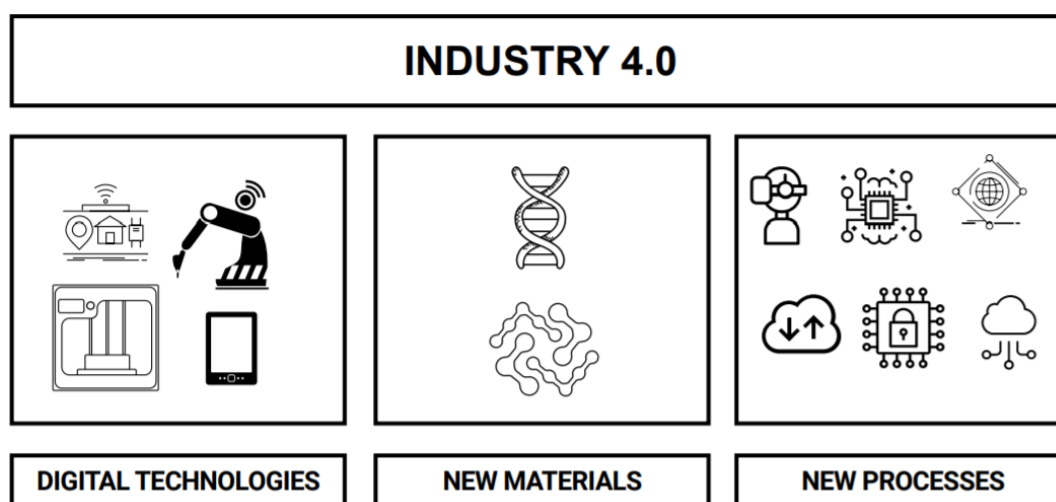


Figure 2. Industry 4.0 involves Digital Technologies, New Materials and Processes. Source: the authors using infogram.com.

The main features of Industry 4.0 are:

- **Interoperability:** cyber-physical systems that allow workers and smart factories to connect and communicate with each other.
- **Virtualisation:** a virtual copy of the smart factory is created by linking sensor data with virtual plant models and simulation models.
- **Decentralisation:** the ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3D printing.
- **Real-Time Capability:** the capability to collect and analyse data and provide the derived insights immediately.
- **Service Orientation:** all services of cyber-physical systems and humans are available internally or even cross-company.
- **Modularity:** flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules ([European Parliament, 2016](#)).



12 enabling technologies are driving Industry 4.0, they are:

- **Big Data and Analytics:** refers to data characterised by their **volume**, **velocity**, namely the speed at which they are generated, accessed, processed and analysed, and **variety** such as unstructured and structured data ([OECD, 2017](#)). **Big Data combined with analytics** allow to generate powerful pattern recognition and automatize functions.
- **Autonomous Robots:** are becoming less costly, less difficult to programme, smaller, more intelligent, autonomous, more connected, and agile.
- **Simulation:** that mirrors the physical world to test and optimize processes and products.
- **Horizontal and Vertical System Integration:** facilitates a more cohesive, cross-cutting, and cross-company automated value chains from suppliers to customers through data-integration networks.
- **Synthetic Biology:** brings the life sciences closer to engineering.
- **Artificial intelligence (AI):** is a term used to describe machines performing human-like cognitive functions such as learning, understanding, reasoning or interacting.
- **3D Printing or Additive Manufacturing:** allows for customised printing of complex objects made from different materials, plastics, glass, metals, or aluminium...
- **Nanotechnology:** through which new properties are being imparted to materials, making them stronger, lighter, or more electrically conductive.
- **The Industrial Internet of Things (IoT):** refers to the connection of devices and objects to the Internet's network of networks using sensors combined with big data analytics and cloud computing.
- **Cybersecurity:** is required due to the increased cyber threats from the integration of manufacturing and production into data-driven systems.
- **Cloud Computing:** allows for computing resources to be accessed in a flexible on-demand way with low management effort.
- **Augmented Reality:** provides workers with real-time information to improve decision making and work procedures thus supporting the production processes.

Box 1. Defining Industry 4.0

The term “**Industry 4.0**” or the **fourth industrial revolution**, refers to “the use in industrial production of recent, and often interconnected, digital technologies that enable new and more efficient processes, and which in some cases yield new goods and services. The associated technologies are many, from developments in machine learning and data science, which permit increasingly autonomous and intelligent systems, to low-cost sensors which underpin the IoT, to new control devices that make second-generation industrial robotics possible” ([OECD, 2017](#), p. 27)

3. Industry 4.0: Opportunities and Challenges

As for the previous three industrial revolutions, **Industry 4.0** offers many challenges and opportunities. The concept **industry 4.0** is of great interest in policy circles as the technologies that revolve around it, namely digital technologies, new materials, and new processes, could spur huge productivity gains for the industrial sector.

Industry 4.0 offers the possibility to “increase productivity, shift economics, foster industrial growth, and modify the profile of the workforce—ultimately changing the competitiveness of companies and regions” ([BCG, 2015](#)). The studies around **Industry 4.0** are optimistic, Boston Consulting Group, for instance, estimated that the productivity boost could increase revenue by €110 billion for the European industry over the next five years ([European Commission](#),



2015). Some analysts suggest that **Industry 4.0** offers the possibility of **re-shoring industries**, that is, the process of returning production and manufacturing activities back to the company's country of origin ([Scalabre, 2016](#)). The premise of industrial reshoring is that knowledge and technology, not labour costs, are the main determinants of competitive advantage. Indeed, increased transportation and labour costs in China, which has been the main recipient of EU offshoring manufacturing activities, could spur re-shoring to the EU ([EPRS, 2014](#)).

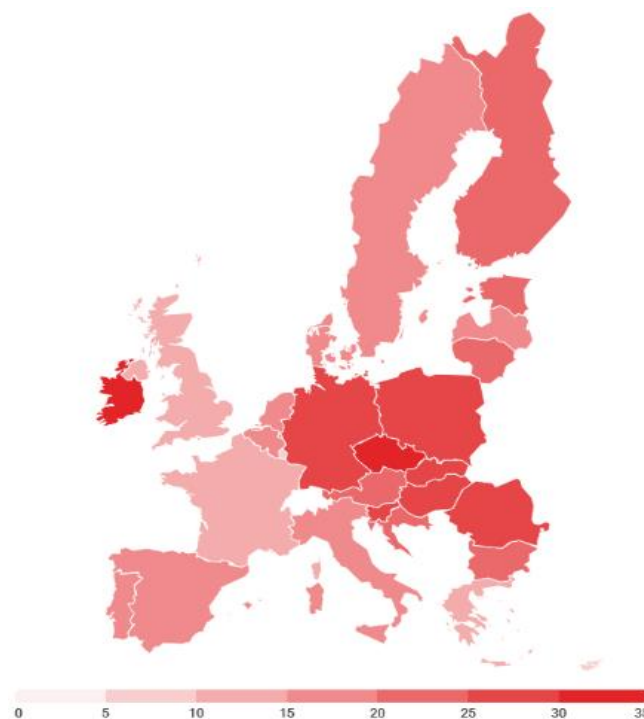
On the other hand, **Industry 4.0** will bring many challenges for policymakers. **Industry 4.0** could disrupt a wide range of sectors from agriculture to the automotive industry and logistics ([Brynjolfsson and McAfee, 2014](#)). European industries are particularly vulnerable. The German automotive industry, the backbone of German exports, face major disruption from self-driving cars ([McGee, 2018](#)). Many jobs are at risk of automation, posing the risk of high structural unemployment. In one study, [Frey and Osborne \(2013\)](#) found that **as high as 47% of US jobs are at high risk of automation**.

For regional innovation policymakers, **Industry 4.0 generates many new challenges** that require different policy responses and the design of suitable instruments. First, policies should consider how to increase new-firm entry and the growth of firms which are major carriers of new technology. Secondly, policies should aim to increase productivity in established firms which face obstacles to the uptake of technology. Indeed, **Small and Medium Enterprises (SMEs) typically use enabling Industry 4.0 technologies less frequently than larger firms**. In Europe, for instance, only 36% of surveyed companies with 50 to 249 employees use industrial robots, compared to 74% of companies with 1 000 or more employees ([Fraunhofer, 2015](#)). SMEs have limited funding capacities to invest in industry 4.0 technologies. Third, **Industry 4.0** will require re-skilling and training workers to new technologies.

4. Industry 4.0 in the European Union

In the European Union, the manufacturing sector plays a major role in the economy and hence the overall societal balance across many European regions. For example, it represents around **1 in 10 enterprises, 2.1 million companies, and 30.4 million jobs in 2016** ([Eurostat, 2019](#)). **The manufacturing sector is responsible for over 80% of exports and 80% percent of private research and innovation** ([EPRS, 2015](#)). In 2010, the turnover of the industrial sector was approximately € 6,400 billion ([European Parliament, 2016](#)).

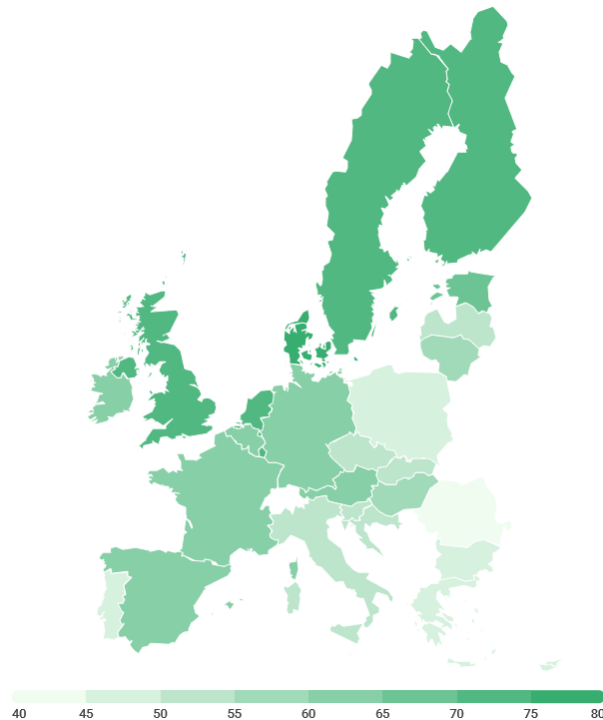
The relative contribution of industry to the EU economy has declined from 20.1% in 2007 to 19.6% in 2017 ([Eurostat, 2017](#)). In 2017, the share of industry in the economy ranges from over 30% in Ireland and Czech Republic to below 10% in Luxembourg and Cyprus (see Map 1).



Map 1. Share of the Industrial Sector in the Total Gross Value Added per Country in 2017. Source: [Eurostat, 2017](#).

The relative decline of the industrial sector in the European Union economy raises questions about its capacity to fully adapt to and take advantage of Industry 4.0. Indeed, the EU industrial sector faces three main challenges that will require policymakers to find policy solutions.

First, the EU Member States have diverse capacities to adapt to Industry 4.0 as measured in the **Digital Economy and Society Index (DESI)**. **DESI** is a composite index that summarises some 30 relevant indicators on Europe's digital performance and tracks the evolution of EU Member States, across five main dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology, Digital Public Services ([European Commission, 2018](#)). In 2016, the DESI ranged from 44 in Romania to 76 in Denmark with an EU-28 average of 59 (see Map 2).



Map 2. The Digital Economy and Society Index (DESI) in 2016. Source: [European Commission, 2018](#).

Second, large investments for the industrial sector are needed to implement the transition to Industry 4.0. They could be as high as €40 billion annually until 2020 for Germany and €140 billion annually in Europe ([EPRS, 2015](#)). However, **the European Union lags behind China, Japan, South Korea, and the United States (USA)** in the acquisition of industrial robots. An industrial robot is defined by [ISO 8373:2012](#) as “an automatically controlled, reprogrammable, multipurpose manipulator programmable on three or more axes, which can be either fixed in place or mobile for use in industrial automation applications”. In 2017, there were 381,335 industrial robots sold around the world ([International Federation of Robotics \(IFR\) 2018](#)). While 137,900 industrial robots were sold to China in 2017, there were only 21,404 units sold in Germany, the largest European market (see Figure 3).

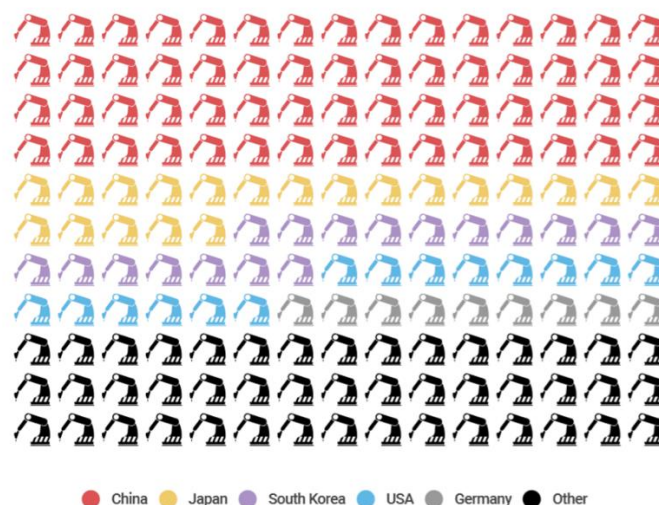


Figure 3. Share of Industrial Robots Bought per Country in 2017. Source: authors using infogram.com made with data from [International Federation of Robotics \(IFR\) 2018](#)



In the European Union, the largest market is Germany, followed by Italy (7,700 units), France (4,900 units), and Spain (4,200 units) ([International Federation of Robotics \(IFR\) 2018](#)).



Figure 4. Ranking of Countries in the European Union Buying the most Industrial Robots in 2017. Source: authors using infogram.com made with data from [International Federation of Robotics \(IFR\) 2018](#)

Third, **the European Union is lagging in research and development in many enabling technologies of industry 4.0.** For example, in artificial intelligence (AI), there were 18,429 patents registered worldwide in 2015. The European Union ranks fourth after Japan, South Korea, and the USA (see Figure 5). Moreover, **the share of European Union patents in AI has declined from 19.1% for the period 2005-10 to 11.9% for the period 2010-15** ([OECD, 2017](#)). In machine learning, which deals with the development of computer algorithms that learn autonomously based on available data and information, the United States leads in this area of research both in terms of total publications and highly cited ones. China ranks second and India third ([OECD, 2017](#)).

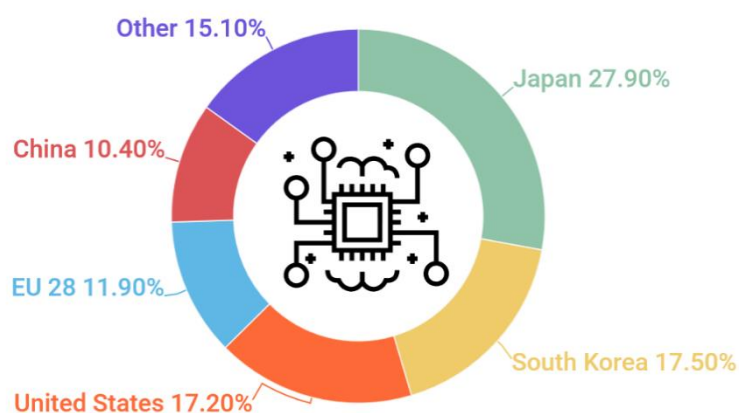


Figure 5. Share of Patents per Country in 2010-15. Source [OECD, 2017](#).

Industry 4.0 Policies in the European Union

The European Commission sees the advent of **Industry 4.0** as an opportunity to raise productivity levels and re-shore industrial activities. In 2012, in response to the decline in the relative importance of industry, the European Commission set a target that manufacturing should **represent 20% of total value added in the EU by 2020** ([EPRS, 2015](#)). Understanding the challenges faced by the European Union to fully take advantage of **Industry 4.0**, the European Commission has pushed for ambitious industrial policy initiatives. The two most relevant policy strategies are the [Digital Single Market Strategy for Europe \(2015\)](#) and [a renewed EU Industrial Policy Strategy \(2017\)](#).



Box 2. Defining Industrial Policy

“The emerging consensus is that the risks associated with selective strategic industrial policy can be minimised through a ‘soft’ form of industrial policy, based on a more facilitative, coordinating role for government, consistent with the systems approach...The goal of ‘soft’ industrial policy is to develop ways for government and industry to work together to set strategic priorities, deal with coordination problems, allow for experimentation, avoid capture by vested interests and improve productivity” ([Rodrik, 2008](#), p. 28).

The Digital Single Market Strategy for Europe (2015) aims to open up digital opportunities for people and business and enhance Europe’s position as a world leader in the digital economy ([European Commission, 2019](#)).

Within the Digital Single Market Strategy for Europe (2015), the European Commission launched in 2016 the **Digitising European Industry (DEI) initiative** to reinforce the EU’s competitiveness in digital technologies ([European Commission, 2019](#)). The five pillars of the **Digitising European Industry (DEI)** initiative are:

- **European platform of national initiatives** on digitising industry to coordinate and ensure coherence among Member States digitising industry initiatives.
- **Digital innovations for all: Digital Innovation Hubs** are ecosystems that consist of SMEs, large industries, start-ups, researchers, accelerators, and investors.
- **Strengthening leadership through partnerships and industrial platforms** to support the development of digital industrial platforms and large-scale piloting and Public-Private Partnerships (PPPs) in key digital technologies such as 5G, big data, High Performance Computing, cybersecurity, photonics, robotics and electronic components & systems.
- **A regulatory framework** fit for the digital age to regulate and provide a digital-friendly regulatory framework in the European Union.
- **Preparing Europeans for the digital future** to adapt the education and learning systems to the digital transformation as well as re-skilling Europeans.

As part of the Digital Single Market Strategy for Europe (2015), the European Commission will encourage investment in network technologies ([European Commission, 2019](#)). The EU is investing in network technologies of the future such as software, services and networks, 5G, the Internet of Things (IoT) and cloud computing through the Horizon 2020 programme.

A renewed EU Industrial Policy Strategy (2017) brings together all existing and sector-specific initiatives into a comprehensive industrial strategy ([European Commission, 2017](#)). The EU Industrial Policy Strategy includes, for instance, **the creation of a European Cybersecurity Research and Competence Centre** to support the development of technology and industrial capabilities in cybersecurity, a proposal for a Regulation on the **free flow of non-personal data**, a new series of actions **on Circular Economy**, a set of initiatives **to modernise the Intellectual Property Framework**, an initiative to improve the functioning of **public procurement** in the EU, extension of the **Skills Agenda**, a strategy on **sustainable finance** to better orient private capital flows to more sustainable investments, initiatives for a **balanced and progressive trade policy** and a European framework for the screening of foreign direct investments that may pose a threat to security or public order, a **revised list of**



critical raw materials, and new proposals for clean, competitive and connected mobility (European Commission, 2017).

2016/2020	EU (ongoing or planned)	Member states	Industry
Digital Innovation Hubs	€500 million (from Horizon 2020)	€5 billion (ESIF, regional budgets)	ca. €17 billion
Public-Private- Partnerships	ca. €4 billion (from Horizon 2020)	nearly €1 billion (contribution for "Electronic Components and Systems for European Leadership (ECSEL) Partnership")	
National policies/ digitalisation strategies		€15 billion (planned national digitalisation programmes)	
Important Project of Common European Interest (IPCEI) on Electronics – planned	€300 million contribution for the Electronic Components and Systems for European Leadership (ECSEL) Partnership	€1 billion from member states (e.g. France, Germany, Netherlands, Italy and Britain)	€5 billion
European Cloud Initiative	ca. €2 billion from Horizon 2020 are being invested into the European Cloud Initiative	€4.7 billion in additional resources from private and public sources for European data infrastructure	

Table 1. Estimated investments in Digitising European Industries. Source: [Friedrich-Ebert-Stiftung, 2018](#).

The issue of industrial transition, which represents one of the important consequences of Industry 4.0, is also tackled by the **European Commission, Directorate - General Regional and Urban Policy (DG REGIO)**. Considering the EU cohesion policy and the confirmation of the Smart Specialisation Strategy (S3) for the next programming period 2021-2027, DG Regio is focusing on addressing the challenges related to regional industrial transition. **One of the fulfilment criteria for the enabling conditions for Smart Specialisation Strategy (S3) under ESIF 2021-2027 concerns actions to manage industrial transition**, which comprises five guiding questions to: (1) prepare for the jobs of the future, (2) broaden innovation and innovation diffusion, (3) encourage low-carbon energy and circular economy transition, (4) promote entrepreneurship and mobilise the private sector, and (5) pursue inclusive growth.



Box 3. Interreg Projects and S3 Platform for Industrial Modernisation (S3P-Industry)

The [Smart Specialisation Platform for Industrial Modernisation \(S3P-Industry\)](#) aims to support EU regions committed to generate a pipeline of industrial investment projects following a bottom-up approach—implemented through interregional cooperation, cluster participation and industry involvement. There are currently over 20 such partnerships. One of the thematic areas is the [SME integration to Industry 4.0](#), which aims to support SMEs in absorbing new digital technologies and adapting to Industry 4.0, organised an interregional conference on Industry 4.0, Manufacturing and Interregional Cooperation, on 19 March 2019 in Florence, Italy. [Interreg Europe Projects contributing to Industry 4.0 Modernisation](#), namely [NMP-REG](#), [TRINNO](#), [INNO PROVEMENT](#), [MARIE](#), and [STEPHANIE](#) came together during the conference to answer the question, “what does the term Industrial Modernisation mean to you?”. Other S3P-Industry partnerships focus on specific technologies such as Artificial Intelligence and are led by regional innovation agencies such as ART-ER from Emilia-Romagna that are also key players in a number of Interreg Europe innovation projects.

5. Interreg Europe Industry 4.0 Projects

Many Interreg Europe projects from the Thematic Objective Research and Innovation tackle specific policy challenges related to **Industry 4.0** (See Annex 1 for the list of Interreg Europe projects involved in Industry 4.0). For instance, some of them aim to facilitate the diffusion of Industry 4.0 technologies to SMEs, to better deliver and evaluate Industry 4.0 policy-mixes, and to foster the adoption in the industrial sector, of emerging digital technologies, new materials, and new processes. Others are also aligned with key sectors and linked to the S3P-Partnerships.

The following paragraphs provide a general overview of the different aspects of Industry 4.0 tackled by our projects.

Industry 4.0 implies the use of **new materials** such as bio- or nano-based materials. [SMARTPILOTS](#) and [NMP REG](#) are dealing with improving policies to promote new materials. [SMARTPILOTS](#) focuses on shared innovation infrastructures or Shared Pilot Facilities (SPF) for the bio-based economy to develop, prototype, and scale-up the next generation of sustainable products and processes in industrial **biotech and the bio-economy**. [NMP REG](#) aims to support the manufacturing sector applying **nanotechnologies and new materials** in their products and services.

Approaches to delivering Industry 4.0 imply the diffusion of **new processes** to the manufacturing sector. [REGIONS 4 FOOD](#) aims to spread the use of **big data** in the food sector to improve traceability across the value chain. Within the food value chain, **big data** is increasingly adopted in areas such as security and traceability management, customer service, or production improvements. The Smart Specialisation Platform for Agri-Food ([S3P Agri-Food](#)) tackles similar issues indicating potential synergies between [S3P-Industry and Interreg Europe Projects](#).

Industry 4.0 also implies the use of **emerging digital technologies such as industrial robots, 3D printing...** that entail a reorganisation of production processes in the



manufacturing sector. **INNO INFRA SHARE** aims to improve the exploitation of Research and Innovation Infrastructures (RIIs) at the regional levels for SMEs in the field of Key Enabling Technologies (KETs). Research and Innovation Infrastructures provide scientific equipment, knowledge-based resources, e-infrastructures, and virtual infrastructures to facilitate diffusion and “early adoption” of technology, especially by SMEs.

Regions that seek to implement Industry 4.0 programmes must define coherent policy mixes and create new policy instruments to strengthen the industrial sector. **MANUMIX** aims to improve the effectiveness and efficiency of innovation policy-mixes for advanced manufacturing at regional level through the evaluation of the interactions among different policy instruments to find the best synergies. **INNO INDUSTRY** focuses on the role of clusters in promoting Industry 4.0 solutions.

One of the main policy challenges is to facilitate the adaptation and promote the diffusion of Industry 4.0 technologies in SMEs. **INNO PROVEMENT** assists SMEs to access new processes such as software and digital tools to improve their competitiveness. **SMARTY** was created out of the **Industry 4.0 Partnership of the Thematic Smart Specialisation Platform (TSSP) on Industry Modernisation** to overcome fragmentation of Industry 4.0 solutions and to diffuse Industry 4.0 solutions and technologies to SMEs. **DIGITAL REGION** aims to provide greater policy coherence for regional innovation policies targeting Industry 4.0 within multi-level governance and smart specialisation strategies (S3).

The policy challenges related to Industry 4.0 are not only addressed in Interreg Europe projects that are part of the thematic objective 1 research and innovation but also in **the thematic objective 3 SMEs and competitiveness**. The Interreg Europe project, **40READY**, for instance, aims to prepare SMEs to embark on Industry 4.0 implementation through supporting capacity-building and re-skilling for entrepreneurs, managers, and workers.

Box 4. How can the Policy Learning Platform help projects?

The **Interreg Europe Policy Learning Platform** can help project partners understand the multifaceted dimensions of **Industry 4.0** by facilitating the exchange of experience from different institutional contexts and presenting success stories in industrial modernisation via the **Policy Learning Platform good practice database**. In Interreg Europe, the perspectives from the two thematic objectives Research and Innovation and SME competitiveness, make it a rich platform for exchanges and interregional learning on **Industry 4.0**. In addition to the good practice database, the **Policy Learning Platform** can provide a forum for direct discussions among partners from different projects – either in thematic workshops, peer review learning, or in online discussions and provide access to expert advice.



6. Policy Recommendations

This policy brief on Industry 4.0 reviews six policy recommendations, namely three general and three specific policy recommendations depending on the regional institutional contexts. The policy recommendations are illustrated with interesting practices drawn from within and outside Interreg Europe Projects.

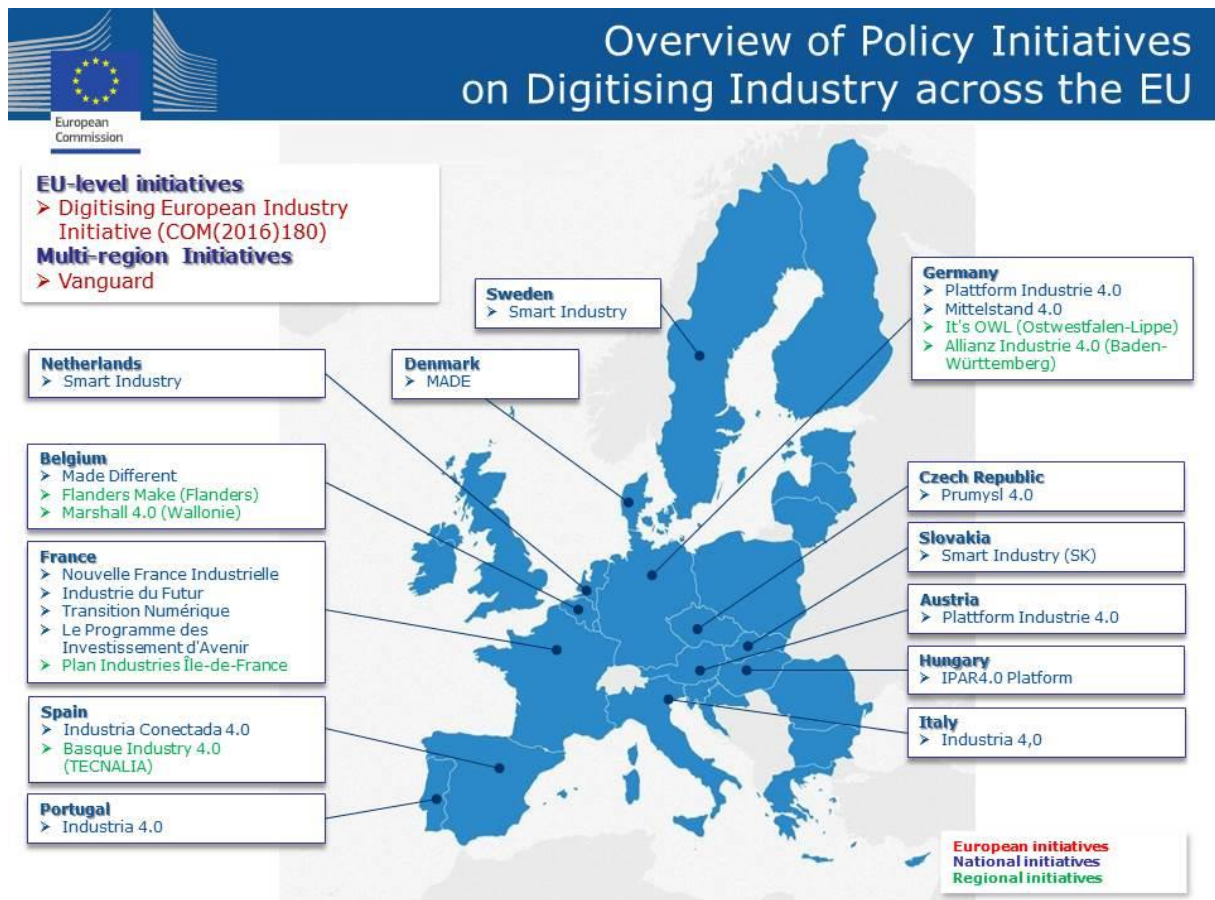
The six following policy recommendations aim to respond to policy challenges faced in European regions such as (1) the importance of a coherent industry 4.0 policy-mix, (2) the importance of skills and reskilling for responding to Industry 4.0 impacts on employment, (3) the need for responsible Industry 4.0 technologies, (4) the importance of Industry 4.0 technologies diffusion to SMEs, (5) the importance of Industry 4.0 technology diffusion to lagging regions, and (6) the importance to promote the next wave of Industry 4.0 technological innovations in leading regions.

Policy recommendation 1. To Devise Regional Industry 4.0 Strategies.

The first policy recommendation is for regions that have a significant industrial base to shape regional industry 4.0 strategies. The policy complexity of Industry 4.0 requires policymakers to closely work with the private sector to devise a coherent Industry 4.0 strategy to embark in industrial modernisation. This policy recommendation is especially relevant for regions with a significant industrial base (>18% of the regional GDP).



In the European Union, some regions such as Flanders and Wallonia in Belgium, the Basque Country in Spain, or Baden-Württemberg in Germany, have drafted Industry 4.0 strategies (see Map 3). In 2013, the [Vanguard Initiative](#) (for New Growth through Smart Specialisation) was launched. The [Vanguard Initiative](#) is a network of some 30 European regions with high-level political commitment that seek to use their smart specialisation strategies to boost their regional economies through bottom-up entrepreneurial innovation and industrial renewal in European priority areas. The [Vanguard Initiative](#) is currently supporting five close to market industrial domain projects, namely in Advanced Manufacturing for Energy Related Applications in Harsh Environments (ADMA Energy), Bio-Economy-Interregional cooperation on innovative use of non-food Biomass, Efficient and Sustainable Manufacturing (ESM), High Performance Production through 3D-Printing, and New Nano-Enabled Products Pilot ([read the policy brief from the Policy Learning Platform on the Vanguard Initiative](#)). The experience of the [Vanguard Initiative](#) indicates that Industry 4.0 can be a driver for interregional cooperation and co-investment.



Map 3. Digitising European Industry - catalogue of initiatives. Source: [European Commission](#).



Box 5. The Basque 4.0 Strategy

The Basque Country, Spain, was one of the first regions in the European Union to develop an **Industry 4.0 Strategy**. The Basque Country is an important industrial region that went through “two great transformations”. The Basque government has successfully tackled two major economic transformations, the industrial restructuring in the 1980s after the Franco-era and entering the globalisation process in the 2000s. Today, the industrial sector is the main driver of the Basque economy, accounting for **23.5% of the regional GDP**. **The Society of Industrial Promotion and Restructuring (SPRI)** that was created in 1981 by the Basque government is at the centre of these successive industrial transformations. Its mandate has considerably evolved from strictly focusing on industrial restructuring towards the provision of innovation-related policies to promote industrial competitiveness. With the **Basque Industry 4.0 initiative** launched in 2014, the Basque Government aims to strengthen the region’s leadership in industrial activity so that it contributes to 25% of its economy by 2020.

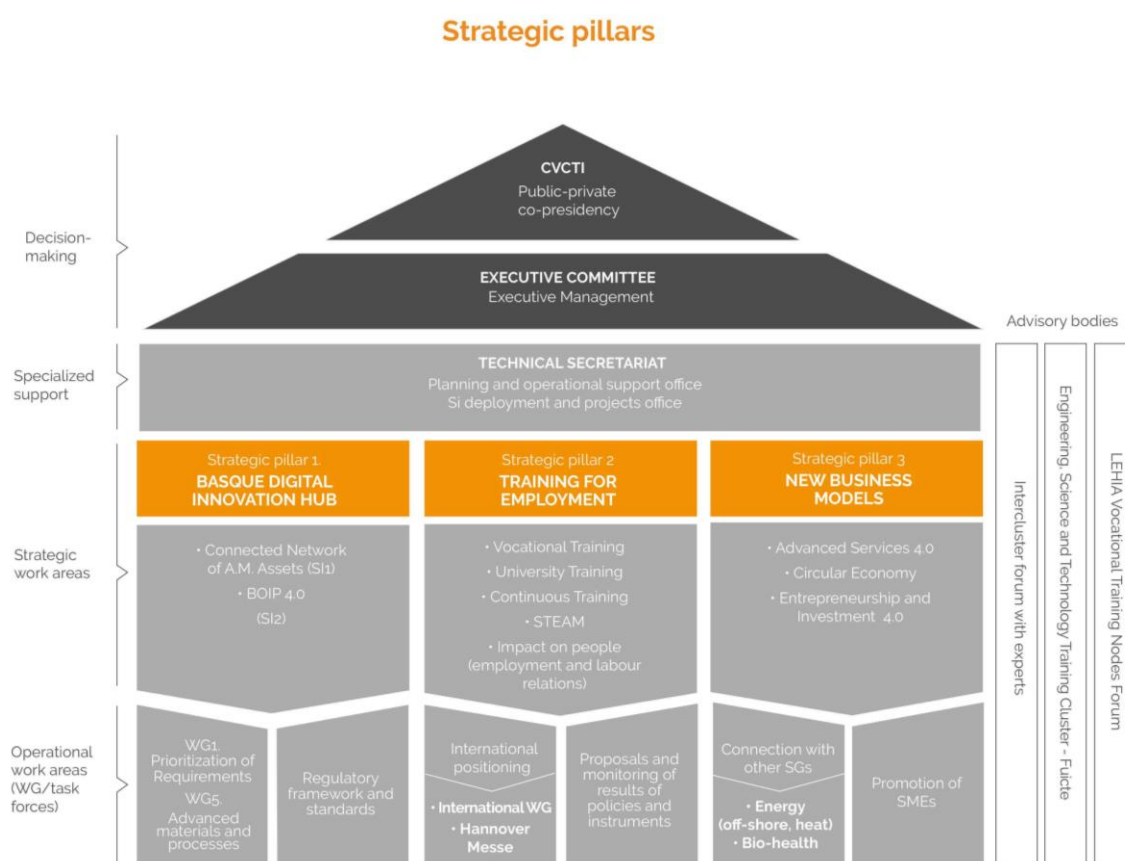


Figure 6. The Strategic Pillars of Basque 4.0 Strategy. Source: **SPRI**.

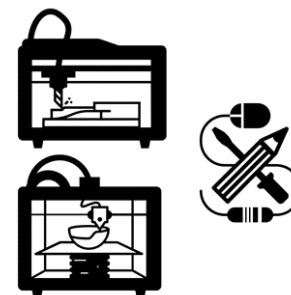


Box 6. How can the Policy Learning Platform support? The Peer Review Service.

The [Interreg Europe Policy Learning Platform](#) can help regions in getting inspired from Good Practices when drafting their regional Industry 4.0 strategy. [Our interregional peer review](#) service is an excellent opportunity for **public bodies or managing authorities in charge of Industry 4.0 Strategies** to receive hands-on feedback from European regions (peers). Industry 4.0 Strategies must be context-specific and require a place-based approach. Regions can benefit from the experience of peers going through similar policy challenges. During the [peer review](#), selected peers from all over Europe will travel to the host region for a two day onsite visit to examine the specific territorial institutional context and make contextualised policy recommendations based on their experience and expertise.

Policy recommendation 2. To Support the Creation of Makerspaces in Higher Education Institutions.

The second policy recommendation is for regions to promote the use of makerspaces in higher education institutions. The skill sets need to considerably evolve to match the needs of industry 4.0 ([WEF, 2016](#)). A makerspace is defined as “a community centre that provides technology, manufacturing equipment and educational opportunities to the public” ([Lifehacker, 2012](#)). As a result, makerspaces can prepare students for the skills needed in industry 4.0.



Makerspaces “allow community members to design, prototype and manufacture items using tools that would otherwise be inaccessible or unaffordable such as 3-D printers, digital fabrication machines and computer-aided design (CAD) software” ([Lifehacker, 2012](#)). Higher education institutions can create makerspaces to support students in using rapid prototyping equipment thus acquiring the skills for Industry 4.0 and sharing their projects, which can be a starting point for students to launch start-ups, get advice on how to place a product in the market, and relate to potential lenders.

[Dos Santos and Benneworth \(2019\)](#) find that makerspaces can have the following benefits: (1) students’ learning is more active, (2) more interactions between students and professors (3) at an early stage, students get in contact with the professional reality of their field, as the projects are related to real engineering problems, and (4) students develop transversal skills.

Box 7. The Interreg Europe Project URBAN M

[URBAN M](#), Urban Manufacturing - Stimulating Innovation Through Collaborative Maker Spaces, focuses on the creation of collaborative maker spaces. Many good practices were identified in [URBAN M](#), among which the [Vilnius Tech Park](#), [Zagreb Makerspace](#), or the [POP UP COMMERCE](#). The Good Practice aims to diffuse the use of maker spaces and to integrate maker space into prototyping and production. The good practices identified in [URBAN M](#) can serve regions aiming to create their own makerspaces.



Policy recommendation 3. To Adopt Responsible Criteria in Public Procurement Tenders.

The third policy recommendation is for regions to adopt responsible criteria in public tenders. The new technologies such as big data and analytics, autonomous robots, simulation, synthetic biology, artificial intelligence (AI), cybersecurity, augmented reality that are being used in Industry 4.0 have some important ethical implications.



The EU has taken many steps to ensure responsible use of new technologies. The European Commission has established the **European Group on Ethics in Science and New Technologies (EGE)** to reflect and advise the Commission policies on ethical, societal and fundamental rights issues that result from the development of science and new technologies such as Artificial Intelligence, gene editing, or future of work ([EC, 2019](#)). The EU has passed the **General Data Protection Regulation (GDPR)** to ensure data protection and privacy for all individuals within the European Union (EU) and the European Economic Area (EEA). The European Commission is also working on ethical guidelines on Artificial Intelligence ([EC, 2019](#)).

Regions can adopt responsible regulatory framework in Industry 4.0 technologies. The responsible regulatory framework offers industry and science clear legal boundaries and reduces risks related to blurry legal frameworks when prototyping and testing new technologies, thus lowering overall transaction costs for science and industry.

Box 8. The Interreg Europe Project MARIE: A Policy Change

The Interreg Europe Project, [MARIE](#), MAinstreaming Responsible Innovation in European S3, tackles the challenge of operationalising the responsible research and innovation concept to the regional scale and to integrate it within the smart specialisation strategy (S3). Working with [MARIE](#) partners, Tampere Regional Council and Tampere University have introduced responsible criteria such as ethics, engagement, openness/transparency and safety/reliability into a regional **ERDF call on Artificial Intelligence** (“Sustainable growth and jobs 2014 - 2020 - Finland's structural funds programme”). The [policy improvement](#) was inspired by the good practice from Ireland, [Broadening the Scope of Impact](#), owned by Science Foundation Ireland, as to how to focus the evaluation of the RRI criteria and the technical execution of the evaluation tool.

Policy recommendation 4. To Promote Public-Private Partnerships to Diffuse Industry 4.0 Technological Innovations.

The fourth policy recommendation is for regions to promote public-private partnerships (PPP) to diffuse industry 4.0 technological innovations, namely to SMEs. Diffusion, and more importantly the speed of diffusion of technologies and their effective take up is essential for economic development. **International technology diffusion** determines productivity and growth differences, partly because only a handful of rich countries account for most of the world's creation of new technology ([Keller, 2004](#)).





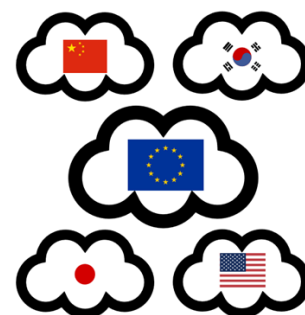
Regions can create through public-private partnerships or public-private initiatives intermediary organisations to oversee the promotion of diffusion of Industry 4.0 technologies. The public-private partnership intermediary organisations have more flexibility and autonomy, regarding personal and financial management thus improving the delivery of the policy objective to diffuse Industry 4.0 technologies. Moreover, managerial autonomy and reduced political influence might increase efficiency, effectiveness and accountability of the intermediary organisation.

Box 9. Learning from Interreg Europe Good Practices

From the [AGRI RENAISSANCE](#) Interreg Europe Project, the [Healthy Rioja Strategy](#) is an initiative to promote innovation for SMEs in the food sector. Product innovations coming from biotechnology and process innovations coming from industry 4.0 are increasingly disrupting the agricultural and food sector. The [Healthy Rioja Strategy](#) provides technology watch, support mechanisms for proof-of-concepts and prototyping, knowledge transfer, and collaboration among triple helix stakeholders to diffuse Industry 4.0 technologies in a traditional sector. The initiative stresses the importance of public-private collaboration to promote the diffusion process of new technologies.

Policy recommendation 5. To Promote Diffusion of Industry 4.0 Technological Innovations in Lagging Regions.

The fifth policy recommendation is for lagging regions to promote the diffusion of Industry 4.0 technological innovations. In these regions, regional policymakers often overestimate their regional innovation systems' capacity to develop new ideas and to produce technological innovations. In lagging regions, **regional innovation policies must promote the diffusion of Industry 4.0 technologies and adapt the technologies to the regional context** through increasing the absorptive capacity of local stakeholders, namely SMEs, to adopt new technologies.



The topics of **Industry 4.0 and Industrial Modernisation** is not only tackled within the European Union. Regions in the EU must also look at good practices coming from other leading countries in **Industry 4.0** such as China, Japan, South Korea, and the United States. China, for instance, has launched an ambitious industrial policy plan called titled [China 2025](#) to become the world leading industrial powerhouse thanks to industry 4.0 technologies. While lagging regions should promote the diffusion of technologies from innovation hubs, leading regions should also promote extra-regional linkages with strategic leading regions in industry 4.0 technologies.



Box 10. Learning from Outside the European Union

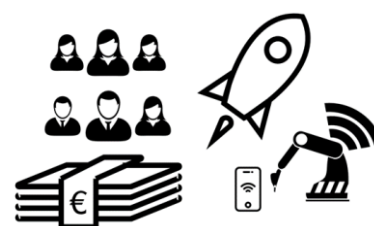
In Medellin, Colombia, the innovation agency, [Ruta N](#), has promoted extra-regional linkages with innovation hubs around the world to foster the diffusion of new technologies. The innovation agency has established the **first Latin American Centre dedicated to the Fourth Industrial Revolution to diffuse Industry 4.0 technologies and practices** into the regional innovation ecosystem. For [Ruta N](#), the diffusion of extra-regional knowledge has three objectives: first, to improve the capacity of the innovation ecosystem to acquire, absorb, and diffuse extra-regional knowledge; second, to connect Medellin to relevant innovation hubs and generate formal and informal networks; and third, to improve the visibility of Medellin N as a relevant innovation ecosystem in the world. According to [Morisson](#) (2019), the innovation agency, [Ruta N](#), was able to diffuse extra-regional knowledge by facilitating its absorption for regional actors through tropicalising the extra-regional knowledge, that is through contextualising the knowledge to the regional context.

Box 11. Learning from Interreg Europe projects

From the [MANUMIX](#) Interreg Europe Project, the [Basque Industry 4.0 – Technology transference of electronics & ICTs for advanced manufacturing](#) is an initiative to promote the diffusion of industry 4.0 technologies that originated in science to the industry. The diffusion of Industry 4.0 technologies should not only be promoted from outside the regional innovation ecosystem but also from within the ecosystem. Indeed, diffusion barriers also exist between science and industry. As a result, regions that have weak science-industry linkages can get inspired from the experience of the Basque Country in **promoting diffusion of Industry 4.0 technologies between Science and Industry**.

Policy recommendation 6. To Promote Disruptive Industry 4.0 Technological Innovations in Leading Innovative Regions.

The sixth policy recommendation is for leading innovative regions to promote disruptive Industry 4.0 technological innovations. Regions that are ranked as innovation leaders in the [Regional Innovation Scoreboard](#) should promote the next wave of radical and disruptive technological innovations to remain at the technological frontier and innovation leaders.



As pointed out in the article [Grand Challenges: The New Mission-Oriented Innovation Frontier](#), Horizon Europe, the next research and innovation framework programme for the period 2021-2027, offers regional governments the opportunity to experiment and create bold mission-oriented innovation policies. Mission-oriented innovation policy tools can support regions to promote the next wave of disruptive and radical Industry 4.0 innovations. The pursuit of mission-oriented policies, however, is more relevant for regions that are ranked as innovation leaders as those regions already have the critical mass of innovative actors and a well-functioning innovation ecosystem to support the next wave of disruptive innovations.

**Box 13. Learning from Regional Mission-oriented Policy Tools**

The Northern Netherlands Provinces Alliance designed the Open Innovation Call thanks to the exchanges with BeyondEDP partners and experts. The Open Innovation Call is a programme that follows a mission-oriented innovation policy approach as it focuses on specific goals and regional challenges rather than on specific industrial sectors. The good practice, which has a budget of €20 million for two years and can contribute to 40% of the total eligible costs, specifies strictly defined objectives but not the actions to reach those objectives. The selected projects must follow a collaborative approach, an integrated approach, generate business creation, have a lasting impact, and generate social significance. An interdisciplinary panel of external experts—from the private sector, the public sector, and universities—select the projects. The Open Innovation Call offers regional policymakers an inspirational example on how to adapt the concept of mission-oriented innovations to the regional level.



Sources of further information

- European Parliamentary Research Services (2014) – [Reshoring of EU Manufacturing](#)
- European Parliamentary Research Services (2015) – [Industry 4.0](#)
- European Commission (2015) – [Digitising European Industry](#)
- European Commission (2017) – [A Renewed EU Industry Policy Strategy](#)
- European Commission (2018) – [International Digital Economy and Society Index 2018](#)
- European Commission (2019) – [Digital Single Market](#)
- European Parliament (2016) – [Industry 4.0](#)
- Fraunhofer (2015) – [Fresh look at the use of robots shows positive effect of automation](#)
- Friedrich-Ebert-Stiftung (2018) – [Industry 4.0 and European Innovation Policy](#)
- Institute for Security & Development Policy (2018) - [China 2025](#)
- S3 Platform - [Industry 4.0 Partnership of the Thematic Smart Specialisation Platform \(TSSP\) on Industry Modernisation](#)
- OECD (2017) – [The Next Production Revolution](#)
- World Economic Forum – [The Fourth Industrial Revolution](#)

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Annexe 1: Selection of relevant Interreg Europe projects dealing with Industry 4.0

Project	Policy Objective
40READY	To develop Industry 4.0 skills for entrepreneurs, managers, and factory workers.
DIGITAL REGION	To provide greater policy coherence for regional innovation policies targeting Industry 4.0.
INNO INDUSTRY	To support clusters in promoting Industry 4.0 solutions.
INNO INFRA SHARE	To improve the exploitation of Research and Innovation Infrastructures (RIIs) at the regional levels for SMEs in the field of Key Enabling Technologies (KETs).
INNO PROVEMENT	To assist SMEs to access new processes such as software and digital tools to improve their competitiveness.
MANUMIX	To improve the effectiveness and efficiency of innovation policy-mixes for advanced manufacturing through policy evaluations.
MARIE	To promote Responsible Research and Innovation (RII) in Smart Specialisation Strategies (S3)
NMP REG	To support the manufacturing sector to apply nanotechnologies and new materials in their products and services.
REGION4FOOD	To promote the use of big data in the food value chain to improve traceability in the food value chain.
SMARTPILOTS	To support effective Shared Pilot Facilities (SPF) for the bio-based economy.
SMARTY	To diffuse Industry 4.0 solutions and technologies to SMEs.
URBAN M	To promote the use of collaborative makerspaces.

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#industry4.0 #industrialmodernisation
#innovationsystems #policylearning*



Thematic experts:

Arnault Morisson & Marc Pattinson

a.morisson@policylearning.eu

m.pattinson@policylearning.eu

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