European Commission

Joint Research Centre

SCIENCE FOR POLICY BRIEF

Strengthening EU Innovation Policy

Insights from the Regional Innovation Output Indicator

2025

HIGHLIGHTS

- The Regional Innovation Output Indicator (RIOI) is a new tool introduced by the European Commission, that provides a snapshot of innovation output across EU regions.
- According to the 2025 edition, innovation output is unevenly distributed across EU regions. It is predominantly concentrated in Central and Northern European countries, with regions in Sweden, Germany, Denmark, and Finland consistently outperforming the EU27 benchmark. In contrast, most regions in Southern and Eastern European member states score below the EU27 average.
- The RIOI ranking is led by Stockholm (SE11), Oberbayern (DE21), Berlin (DE30), Praha (CZ01), and Ile-de-France (FR10). In contrast, the three lowest-performing regions are all located in Romania.
- Capital city regions consistently rank among the top-performing regions within their respective country in terms of innovation output. This pattern is particularly pronounced in Southern and Eastern European member states, underscoring the over-concentration of innovation activity in urban centres.

The innovation output of EU regions

Regional innovation ecosystems are not evenly distributed across the European Union. Innovation tends to cluster in specific geographic hotspots [1,2], emphasising the role of regional capabilities in shaping national innovation performance. The European Commission continuously supports **regional innovation** through several programmes, including the European Structural and Investment Funds, Horizon Europe programmes, and the Reginal Innovation Valleys Initiative. Amid growing regional disparities in research and innovation (R&I) performance across the EU [2], a more systematic approach to monitoring innovation output at the regional level is essential. Promoting a balanced innovation landscape within national regions not only fosters equitable growth but also enhances the EU's collective competitiveness and ability to achieve its green and digital transformation goals.

Monitoring innovation performance at the regional level has long been a priority for the European Commission. The Commission regularly produces the Regional Innovation Scoreboard (RIS), a comparative assessment of innovation performance across EU regions [1]. Building on this, the Commission launched the Regional Innovation Output Indicator (RIOI) in 2025—a novel, multidimensional monitoring tool that provides an output-oriented measure of innovation performance for NUTS-2 regions.

The RIOI tracks the extent to which innovative ideas within regions are able to reach the market, create

QUICK GUIDE

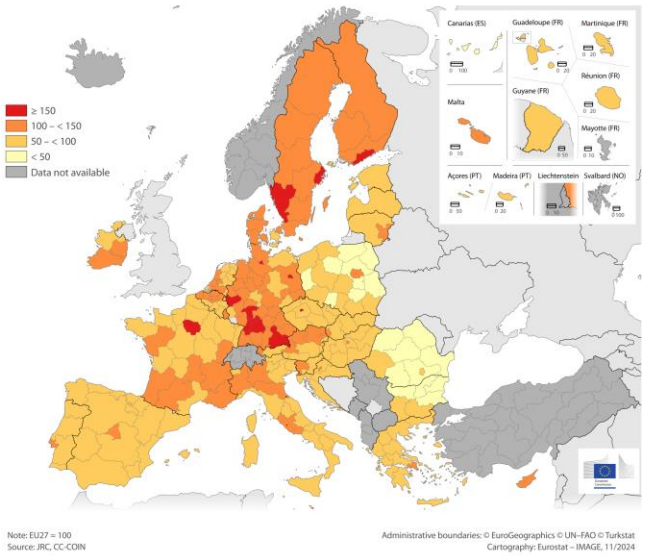
Composite indicators and scoreboards are widely used to capture both the process and the outcomes of complex phenomena such as innovation. In 2025, the Joint Research Centre of the European Commission launched the first edition of the Regional Innovation Output Indicator (RIOI). This work extends the national IOI produced within the INNOVA projects since 2013. Like its national counterpart, the RIOI is an output-oriented measure of regional innovation for the NUTS-2 EU regions that measures regional capacity to derive economic benefits from innovation. The RIOI tracks the extent to which innovative ideas within regions are able to reach the market, create knowledge-intensive jobs, and increase regional technological capability.

The RIOI includes seven indicators combined in four components: 1) the number of Patent Cooperation Treaty (PCT) patent applications, and the number of trademark classes in total resident trademark applications, each denominated by population (in millions); 2) the persons employed in medium-high and high-tech manufacturing and knowledge-intensive service business industries as a share of total employment; 3) the domestic (regional) value added content of international medium-high and high-tech manufacturing exports as a share of total international manufacturing exports, and the domestic (regional) value added content of international knowledge-intensive service exports as a share of total international service exports; and 4) the share of small and medium enterprises (SMEs) introducing product and business process innovations over the total number of SMEs.

better jobs, and increase a region's technological capabilities. It aggregates four components: 1. patent and trademark counts, 2. employment in knowledge-intensive activities in business industries[1], 3. contribution of regional technological capacity to exports in knowledge-intensive industries, and 4. share of innovative small and medium enterprises (SMEs). This policy brief introduces the findings of the first edition of the RIOI, providing a snapshot of regional innovation output across 241 EU regions and in comparison, with the EU27 benchmark (**Figure 1**).

The RIOI results confirm that the regional innovation divide persists in the EU. The best performing regions in terms of innovation output are primarily located in Central and Northern European countries including Germany, France, Belgium, the Netherlands, Denmark, Sweden, and Finland. Stockholm (SE11), Oberbayern (DE21), Berlin (DE30), Praha (CZ01), and Ile-de-France (FR10) regions lead the RIOI ranking[2]. On the other hand, most Mediterranean and Eastern European regions score below the EU27. At the bottom of the ranking, the lowest-performing regions include two from Poland and three from Romania[3].

Figure 1 – Regional Innovation Output Indicator for NUTS-2 EU regions, 2024.



Source: Bello et al. 2025. Note: values normalized to the EU27 value (= 100). Darker colors denote larger values of the RIOI.

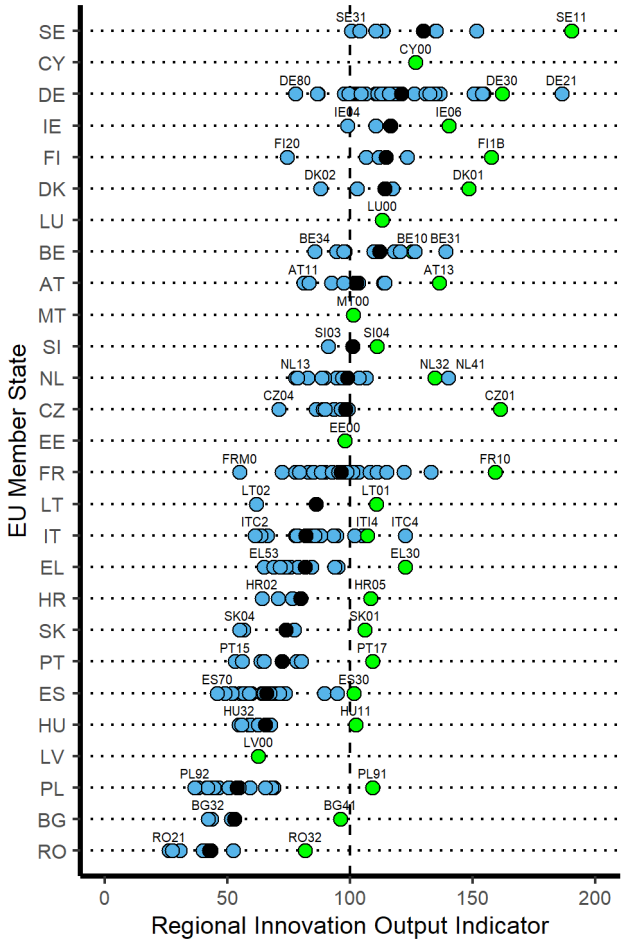
An analysis of the RIOI and its drivers supports these findings, highlighting that innovation output tends to cluster at the regional level [5] (see **Box 1**).

[1] These are NACE manufacturing and services industry sectors with high technological intensity See [2] for detailed information.

[2] The top 10 is completed by Helsinki-Uusimaa (FI1B), Stuttgart (DE11), Köln (DEA2), Karlsruhe (DE12), Hamburg (DE60), Västsverige (SE23), and Darmstadt (DE71)

[3] These are Świętokrzyskie-PL72, Mazowiecki regionalny-PL92, Sud-Est-RO22, Sud-Vest Oltenia (RO41) and Nord-Est (RO21) respectively.

Figure 2 – Regional Innovation Output Indicator for NUTS-2 EU regions, 2024, grouped by country.



Source: Bello et al. 2025. Note: Dotted line represents EU performance. RIOI values normalized to the EU27 value (= 100). Green dots represent country capital regions and black dots the average RIOI over a country's regions. Countries ordered by average RIOI scores. Names refer to the NUTS-2 codes of each country's capital, top, and bottom performing region.

At the national level, capital city regions consistent-ly outperform other regions in terms of innovation output (**Figure 2**). This stylized fact, which is also observed in other regional multidimensional indices[4], highlights the concentration of innovation ac-tivities in major cities, which could also reflect an HQs effect. As headquarters are typically concen-trated in capital and major cities, they drive innova-tion through resource pooling, talent attraction, and knowledge spillovers, further reinforcing the ag-glomeration of innovation activities in these hubs.

In six countries, namely Sweden, Belgium, Finland, Germany, Denmark, and Ireland, strong innovation output performance is dispersed with more than 60% of the NUTS-2 regions outperforming the EU27 benchmark. In contrast, in the South and Eastern Europe, only one region scores better than the EU27 benchmark. These regions typically include the capital city, as in Greece, Spain, Portugal, Croatia, Hungary, and Poland, or no regions at all as in Bulgaria, and Romania.

Box 1: Facilitators and barriers to regional innovation

A region's geographical location can play a role in the facilitation or impediment of innovation activity [5]. Additional analysis for the case of innovation output confirms the existence of spatial dependency across regions, namely that regions closer to each other tend to have similar performance [4].

A significant regional cluster is identified in Central and Northern Europe, where most ad-jacent regions have similarly high RIOI scores. This includes the top-performing regions in terms of innovation output such as Île-de-France and Praha. In the former, the Paris-Saclay cluster facilitates knowledge transfer and collaboration in areas like Artificial Intelli-gence and biotechnology by acting as the meeting point for academic institutions, re-search centres, and leading corporations. In the latter, a large pool of skilled workers, ade-quate infrastructure, and the concentration of state institutions, universities, and a diverse range of companies create a unique innovation incubator [5].

On the other hand, human capital and entre-preneurial activity in Eastern and Southern Eu-rope tend to be excessively accumulated in capital and major cities, which is often at the expense of neighbouring regions. In these re-gions, factors such as the insufficient policy support and the absence of tailored regional plans for business innovation (as in Polish re-gions [5]), and the centralisation of activities in capital cities reinforce local brain-drain in pe-ripheral regions and diminish the local work-force's potential (as in Hungarian and Italian regions [9]).

[4] Such as the EU regional Social Progress Index (see [5])

A closer look at the RIOI components

The components of RIOI provide insights into the dimensions of innovation that drive regional innovation performance. These insights can enable regional policymakers to identify strengths, success stories, as well as areas for improvement, supporting the development of targeted, evidence-based strategies.

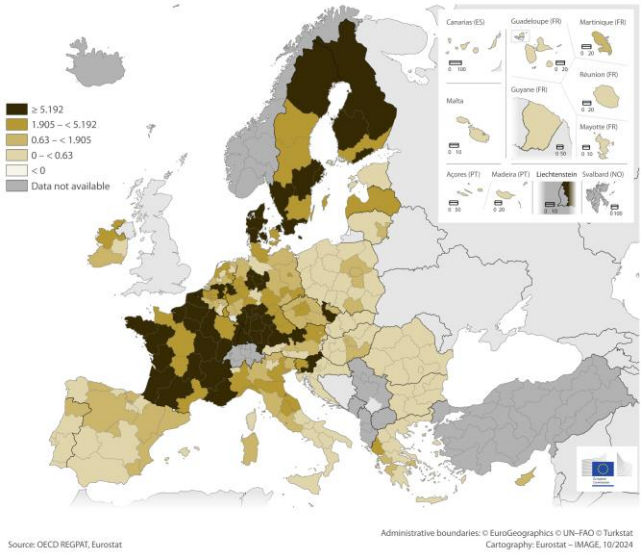
According to 2024 RIOI results[5], Ile-de-France (FR10) records the highest number of Patent Cooperation Treaty (PCT) patent applications per million population, followed by Noord-Brabant (NL41) and Nordjylland (DK05). Patent activity is most pronounced in French, German, Danish, Swedish, and Finish regions (**Figure 3**), aligning with national-level trends where Germany and France accounts for the highest share of patenting activity of the EU [6]. In contrast, 69 EU regions - predominantly in the South and Eastern Europe-did not file any patent application in 2021.

Malta, Luxembourg, and Cyprus lead the EU regional ranking in terms of trademark applications per million population[6]. However, these regions collectively account for less than 1% of the EU27's total trademark applications [6].

When compared to EU averages, only 60 regions filed more patent applications per million population than the EU27 benchmark (4.3), while 82 regions outperformed the EU average in terms of trademark output (215 per million population). On average, the 241 EU regions produced 2.9 patents and 355 trademarks per million population in 2021.

The RIOI also includes a region's share of regional value added in knowledge-intensive exports[7]. As most of today's exports are not fully produced in the exporting region or country, their gross value incorporates a certain share of value added by other countries in imported intermediates. Because of this, looking at gross export value is not always an effective way to assess a country's or region's competitiveness. The share of domestic value added in exports provides a better indication of domestic technological capabilities and highlights the extent to which regions rely on foreign inputs to produce exported goods and services.

Figure 3 – Number of patent applications by region of resident per million population (equivalent count), 2021.



Source: Bello et al. 2025. Note: Darker colors denote larger values.

In 2017[8], a sizeable proportion (more than 25% on average) of the value of the knowledge-intensive manufacturing **product exports**[9] of EU regions to other countries (EU or non-EU) was generated within the regions themselves. For 21 regions this share was larger than 50%. However, regions with larger shares -and thus less reliance to foreign inputs- tend to be highly concentrated in Central Europe, particularly in Germany, Northern Italy, and Southern France, suggesting a competitive advantage in knowledge-intensive manufacturing for these regions. The regions of Berlin (DE30) and Lombardia (ITC4) lead the regional ranking, with a share of domestic value added in knowledge-intensive exports exceeding 70%.

In contrast, the EU regions contributed on average 33% to the value added of the knowledge-intensive

[5] The RIOI is developed as a snapshot of innovation output using the latest available data in 2024 (year of data collection) for each of the variables. The final data point in our patent data series is 2021, accounting for typical delays in patent data collection and updates.

[6] Five countries (Cyprus, Estonia, Latvia, Luxembourg, and Malta) are included in the RIOI only at the country level because their NUTS-1 and NUTS-2 regions are identical to their national territory.

[7] Exports refer to products or services exported from an EU region abroad, that is, to other countries (either within or outside the EU).

[8] the benchmark year of FIGARO-REG database.

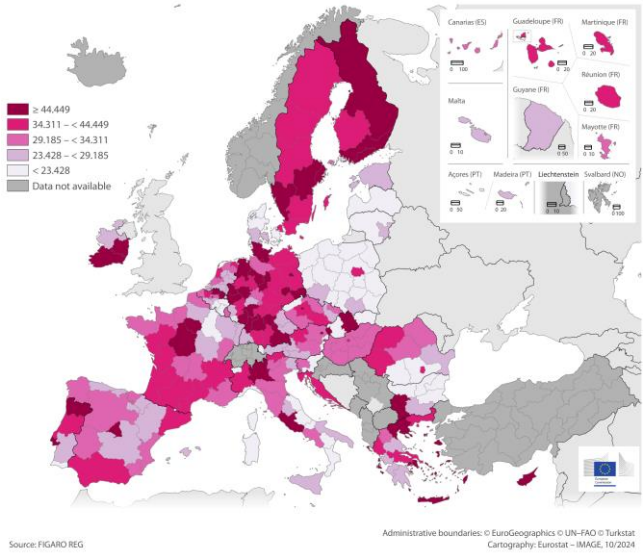
[9] Regional trade indicators in the RIOI are developed from the Joint Research Centre's (JRC) FIGARO-REG multiregional input-output table [7]. Their focus on international trade is in concordance with notions of regional competitiveness which place importance on a region's ability to produce goods and services that meet the needs of international markets [8].

service exports. The top-performing regions in this domain are more evenly distributed across European countries (**Figure 4**), including Southern and Eastern European areas. Overall, this underscores the strong domestic capabilities in service provision across the EU. Among the 15 best performing regions in terms of this indicator, regions such as Köln (DEA2), Hamburg (DE60), Stockholm (SE11), Centro-PT (PT17), Eastern and Midlands (IE06), and Stredné Slovensko (SK03), generate more than 55% of the value added in their knowledge-intensive service exports domestically.

The share of employment in knowledge-intensive industries is on average close to 47% in EU regions, and it ranges from 68% in Brabant Wallon (BE31) to 20% in Nord-Est (RO21). Larger shares tend to be concentrated in the Northern and Central Europe, with all regions in Sweden and many of those in Belgium, Denmark, Germany, and France having more than 47% of their employment occupied in knowledge-intensive jobs. On the other hand, most regions in Romania, Bulgaria, Poland, Greece, South Italy, and Spain are below the EU average.

Innovation activities are not restricted to knowledge-intensive sectors. The last component of the RIOI monitors product and business process innovation across all sectors of the economy to provide a more comprehensive measure of innovation activity.

Figure 4 – Domestic (regional) value added content of international exports in knowledge-intensive service industries as per-centage of total international service exports, 2017.



Source: Bello et al. 2025. Note: Darker colors denote larger values.

According to the RIOI results, about 42% of SMEs in the EU27 introduced product innovations, while about 27% introduced business process innovations. However, those aggregate figures hide significant heterogeneity among EU regions, as the shares of product and business process innovative firms range from 58% and 73% respectively to a slight 1%. In both cases, high shares of innovative SMEs tend to be concentrated in regions of Central and Northern Europe (Sweden, Finland, Denmark, Germany, Austria) as well as in Greece, Cyprus, and to some extent Italy.

Conclusions and policy recommendations

Deepening our understanding of regional innovation is critical for addressing disparities in innovation performance and fostering equitable, inclusive growth across the EU [1]. This policy brief builds on the findings of the European Commission's Regional Innovation Output Indicator (RIOI) to investigate the innovation performance of EU regions focusing on the output of the innovation process. The index, which was developed for the first time in 2024, tracks the extent to which innovative ideas within European regions reach the market, create better jobs, and increase regional technological capability.

Data from the RIOI confirm that innovation output, as much as R&D activities [2], has a strong regional dimension, and that the innovation divide persists both between EU regions of different countries and among regions within the same country. On the one hand, regions with higher innovation output form a large cluster stretching from the Nordics to Southern France and Northern Italy. On the other hand, certain regions -usually those including capital or major cities- are largely outperforming neighbouring regions within their respective country. Within-country differences in innovation output are amplified in Southern and Eastern Europe. Additional findings demonstrate that spatial concentration increases with technology complexity, suggesting that the most complex technologies -which bear the most potential for future competitiveness- are those concentrated the most [10].

To address these disparities, the EU should not only address the persistent gaps in innovation performance across Member States but also act to facilitate the diffusion of innovation within countries from established innovation hubs to more remote regions. As shown by the RIOI analysis, a region's location matters for its innovation output. Improving connectivity between regions with booming innovation and those lagging behind can be a key action to reducing disparities. For firms located in

remote, lagging, or declining areas, connecting with socio-economic actors located in innovation hubs plays an increasingly significant role in enhancing innovative capacity [11]. For countries such as Sweden and Finland, in which innovation output is quite high across most of their regions (**Figure 2**), latest research identifies connectivity as a decisive factor in the increased innovativeness of firms operating outside major cities [11].

The European Commission's **New European Innovation Agenda** [12] includes actions targeting regional innovation gaps and disparities. The Agenda's actions are a comprehensive toolkit to support European countries in addressing societal challenges, developing new technologies, and making these marketable. It positions Europe at a forefront of deep tech innovation, fostering groundbreaking and inspiring solutions.

The **Regional Innovation Valleys**, one of the 25 flagship actions of the New European Innovation Agenda, aims to enhance collaborations between less innovative EU regions and their more innovative counterparts to create a series of interconnected innovation ecosystems. These ecosystems (Valleys), which are spread across diverse scientific fields – from circular economy [13] to digital health [14]- aim to among others harness the potential of local innovative solutions to address European-wide challenges such as increasing food security, facilitating industrial, circular, and digital transformations.

The **EU Startup and Scaleup Strategy** supports innovation at the regional level through several channels. It promotes stronger interconnected ecosystems by supporting startups, scaleups, and innovative companies through a comprehensive set of actions to address their needs throughout their development. The strategy aims to integrate large companies and corporate investors into the EU's innovation ecosystem through a European Corporate Network. It also facilitates access to infrastructure, networks, and services for regional innovators. Additionally, the strategy introduces regulatory sandboxes to provide startups with testing environments, fostering local collaboration, trust, and investment. [15]

Furthermore, the newly adopted communication on the **Competitiveness Compass** is a comprehensive roadmap for stimulating Europe's innovation, growth and prosperity, in which closing the innovation gap is a central goal [6]. This umbrella of initiatives includes directed actions to create supportive ecosystems for young start-ups and facilitate the diffusion of technologies across established companies and SMEs.

References

[1] European Commission: Directorate-General for Research and Innovation, Regional Innovation Scoreboard 2025, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2777/2313906.

[2] European Commission: Directorate-General for Research and Innovation, Steeman, J., Di Girolamo, V., Mitra, A., Peiffer-Smadja, O. et al. (2024). Why investing in research and innovation matters for a competitive, green, and fair Europe – A rationale for public and private action, Publications Office of the European Union, https://data.europa.eu/doi/10.2777/01237.

[3] Eurostat. Annual data on employment in knowledge-intensive activities at the national level, by sex (NACE Rev. 2, from 2008 onwards). https://doi.org/10.2908/HTEC_KIA_EMP2.

[4] European Commission, Joint Research Centre, Bello, M., Ravanos, P. and Smallenbroek, O. (2025). Tracking country innovation performance: The Innovation Output Indicator 2024, Publications Office of the European Union, Luxembourg, https://data.europa.eu/doi/10.2760/4449831, JRC141343.

[5] European Commission: Directorate-General for Research and Innovation (2024). European innovation scoreboard – Analysis of the regional innovation performance – Main report, Publications Office of the European Union, https://data.europa.eu/doi/10.2777/097400

[6] Al-Ajlani, H., Bello, M. Karvounaraki, A., Ravanos, P., Smallenbroek, O., and Stevenson A. (2025). Putting knowledge and technology to work: Insights from the Innovation Output Indicator, European Commission, Ispra, JRC142093.

[7] Garcia-Rodriguez, A., Lazarou, N., Mandras, G., Salotti, S., Thissen, M. and Kalvelagen, E., (2023). A NUTS-2 European Union interregional system of Social Accounting Matrices for the year 2017: The RHOMOLO V4 dataset. JRC Working Papers on Territorial Modelling and Analysis No. 01/2023, European Commission, 2023, JRC132883.

[8] Kitson, M., Martin, R, & Tyler, P. (2004) Regional competitiveness: An elusive yet key concept?, Regional Studies, 38:9, 991-999.

[9] European Commission: Directorate-General for Research and Innovation (2024). European innovation scoreboard – Analysis of the regional innovation performance – Case studies, Publications Office of the European Union. https://data.europa.eu/doi/10.2777/34739.

[10] European Commission: Directorate-General for Research and Innovation (2022). Science, Research and Innovation performance of the EU, 2022 (SRIP), Publications Office of the European Union, https://data.europa.eu/doi/10.2777/38888.

[11] Rodríguez-Pose, A. (2025). Connectivity and regional innovation, Publications Office of the European Union,

Luxembourg, https://data.europa.eu/doi/10.2760/7684316, JRC134841.

[12] European Commission (2022). A New European Innovation Agenda. COM(2022) 332 final.

[13] European Commission: European Innovation Council and SMEs Executive Agency (2024). A new European innovation agenda – Regional innovation valleys – Project RIVCircular, regional innovation valleys for circular economy, Publications Office of the European Union, https://data.europa.eu/doi/10.2826/2409691.

[14] European Commission: European Innovation Council and SMEs Executive Agency (2024). A new European innovation agenda – Regional innovation valleys – Project UNITE, European digital health valleys, Publications Office of the European Union, https://data.europa.eu/doi/10.2826/1068320.

[15] European Commission (2022). The EU Startup and Scaleup Strategy. COM(2025) 270 final.

Related work

This work is a deliverable of the INNOVA MEASURE VI project (JRC 36562). More information can be found on: https://knowledge4policy.ec.europa.eu/projects-activities/innova-project_en.

Aknowledgements

This policy brief has been prepared by Haya Al-Ajlani, Michela Bello, Athina Karvounaraki, Panagiotis Ravanos, and Oscar Smallenbroek. It benefitted from suggestions and feedback from colleagues in the Competence Centre on Composite Indicators and Scoreboards at the JRC and in the Common R&I Strategy & Foresight Service unit of DG Research and Innovation.

Science for policy

Scan the QR code to visit:

The Joint Research Centre: EU Science Hub
https://joint-research-centre.ec.europa.eu

JRC143873

CONTACT INFORMATION

European Commission, Joint Research Centre (JRC)
Contact: Michela Bello
E-mail: JRC-INNOVA-PROJECT@ec.europa.eu