European Commission

ERA Scoreboard 2023

Methodology Report

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ERA Scoreboard 2023

Methodology Report

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1. Introduction

The European Research Area (ERA) Scoreboard is one of the components of the new ERA Monitoring Mechanism, covering 18 indicators, including two general indicators measuring progress in the European Research & Innovation (R&I) system and 16 specific indicators, one for each Pact for R&I priority.

This Methodology Report provides more details on the measurement framework (Section 2) and the indicator definitions and data sources (Section 3). All data and processed results are available in the ERA Scoreboard 2023 Replication Package.

2. Measurement framework

Based on preparatory work by CSES,[1] an analytical report developed by six experts[2] recommended the use of 18 indicators, including two general indicators measuring progress in the European Research and Innovation (R&I) system and 16 specific indicators, one for each Pact for R&I priority. Advice was provided by the ERA Forum on the final selection of the list of indicators.

The indicators are shown in Table 1 below. The last column includes a short rationale why each of the indicators is included in the ERA Scoreboard. For most indicators this rationale is based on the information included in the study by CSES.

Table 1 : Indicators included in the ERA Scoreboard

	ERA Scoreboard indicator	ERA Pact sub-priorities	Source	Rationale
1	Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP	R&D Investment	Eurostat	Monitors progress towards the 3% R&D target
2	Researchers (in full-time equivalent) per million inhabitants	R&D Investment	Eurostat	Direct measure of the number of R&D workers per 1 million people. It is identical to UN SDG indicator 9.5.2
3	Share of publications available in open access	Open Science	OpenAIRE	Measures the share of publications available in open access
4	Share of national public R&D expenditure committed to joint programmes and initiatives, research infrastructures and European Partnerships	Research infra-structures	Not available	Included in the ERA Pact ("Member States take note of the Commission's proposals to include ... two new voluntary targets for Member States to commit 5 % of national public R&D funding to joint programmes and European Partnerships by 2030")
5	Share of women in grade A positions in higher education institutes	Gender Equality	Women in Science database	Tracks progress in improvements of women's participation in the highest levels of academia

[1] "Data gathering and analysis of policy developments and reforms: Study to evaluate the ERA policy framework/ERA monitoring mechanism" (https://op.europa.eu/en/publication-detail/-/publication/98a8edb4-c763-11ec-b6f4-01aa75ed71a1/language-en/format-PDF/source-256243590).

[2] Amanatidou, E., H. Hollanders, J. Kolar, B. Mahieu, C. Nauwelaers, and M. Guasp Teschendorff, Design of the new ERA Monitoring System – Analytical Report, European Commission, 2022.

	ERA Scoreboard indicator	ERA Pact sub-priorities	Source	Rationale
6	Job-to-job mobility of Human Resources in Science & Technology	Researchers' careers and mobility	Eurostat	Measures the exchange of knowledge resulting from people moving between one job and another. Not all changes in jobs include the creation of knowledge or the diffusion of knowledge, but it is more likely that knowledge creation and diffusion takes place when more employees move between jobs
7	Share of innovating firms collaborating with HEI/PRO out of all innovative firms	Knowledge Valorisation	Eurostat	Measures collaboration, and thus exchange of knowledge between the business and public sector
8	Scientific publications among the top-10% most cited publications worldwide as a percentage of all publications	Scientific leadership	Scopus	Measure for the efficiency of the research system, as highly cited publications are likely to be of higher quality. There could be a bias towards small or English-speaking countries given the coverage of Scopus' publication data
9	International co-publications with non-EU partners per 1,000 researchers in the public sector	Global engagement	Scopus and Eurostat	International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity. Non-EU is defined as non-EU Member States
10	Environmentally related government R&D budget as percentage of total government R&D	Challenge-based ERA actions	OECD Green Growth Indicators Database	Monitors progress on research activities supporting the EU Green deal
11	Share of researchers receiving transferable skills training	Synergies with education and the European Skills Agenda	MORE Survey	Measures the extent of formal and information training received by PhD students
12	Direct government support and Indirect government support through R&D tax incentives as a percentage of GDP	Synergies with sectorial policies and industrial policies	Eurostat for data on direct support OECD R&D Tax Incentive Database for data on indirect support	Public financing of R&D can take two forms: direct funding for R&D through instruments such as grants and public procurement, and indirect support through the tax system. Over time, more countries have introduced R&D tax incentives

	ERA Scoreboard indicator	ERA Pact sub-priorities	Source	Rationale
13	Publications on social innovation per million population	Active citizen and societal engagement in R&I	OpenAIRE	Captures contributions from public and private sector R&I towards solving societal problems
14	Increase in total R&D expenditure, expressed as a percentage of GDP	More investments and reforms in countries and regions with lower R&I performance	Eurostat	Monitors widening countries' share in EU research activities Widening countries include Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia
15	Share of Seal of Excellence rewards that received funding from other sources	Synergies between Union, national and regional funding programmes	Horizon Dashboard	The Seal of Excellence is a quality label awarded by the Commission to proposals which have been assessed in a call for proposals under a Union instrument and are deemed to comply with the quality requirements of that Union instrument but could not be funded due to budgetary constraints. These projects are judged to deserve funding and might receive support from other Union or national sources of funding
16	Number of collaboration networks of RPOs in Widening countries with other EU countries	Increased collaborative links and excellence-based integration of research-performing organisations from countries and regions with lower R&I performance	CORDIS Datalab	Monitors the number of collaborations between Widening countries and other EU countries Widening countries include Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia
17	Share of public R&D expenditures financed by the private sector	Support to prioritise and secure long-term R&I investments and policy reforms	Eurostat	Measures public-private co-operation in research. The willingness of the private sector to co-fund public R&I projects could be a proxy for how closely companies work with universities and public research organisations

	ERA Scoreboard indicator	ERA Pact sub-priorities	Source	Rationale
18	Government budget allocations for R&D (GBARD) allocated to Europe-wide transnational, as well as bilateral or multilateral, public R&D programmes per FTE researcher	Coordination of R&I investments	Eurostat	Reflects the emphasis on collaboration and sharing of experiences in R&D across borders, whether national, regional or organisational. Europe-wide transnational public R&D programmes include R&D programmes that involve the flow of funds across borders for research purposes, as well as those that include transnational cooperation. Bilateral or multilateral public R&D programmes comprise non-European Commission funded R&D research conducted jointly by at least two Member State governments, involving either the flow of funds or transnational cooperation

3. Indicator definitions and data sources

This chapter provides the definitions, data sources, and calculation rules for each of the indicators used in the ERA Scoreboard.

Indicator #1	Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP
Data source	Eurostat
Dataset	GERD by sector of performance [RD_E_GERDTOT] https://ec.europa.eu/eurostat/databrowser/product/view/rd_e_gerdtot?lang=en
Last update	29 March 2023
Time frequency	Annual
Time coverage	2010 – 2021
Unit of measure	Percentage of gross domestic product (GDP)
Countries	EU, 27 Member States, Iceland, Montenegro, Norway, Serbia, Türkiye
Data source	OECD (https://stats.oecd.org/)
Dataset	Main Science and Technology Indicators
Last update	March 2023 edition
Time frequency	Annual
Time coverage	2010 – 2021
Unit of measure	Percentage of gross domestic product (GDP)
Countries	Israel
Data source	UNESCO Institute for Statistics (http://data.uis.unesco.org/)
Dataset	Science, technology and innovation
Last update	February 2023 edition
Time frequency	Annual
Time coverage	2015 – 2021
Unit of measure	Percentage of gross domestic product (GDP)
Countries	Armenia, Georgia

Indicator #2	Researchers (in full-time equivalent) per million inhabitants
Calculation rule	1,000,000 * Numerator / Denominator
Numerator	
Data source	Eurostat
Dataset	R&D personnel by sector of performance, professional position and sex [RD_P_PERSOCC] https://ec.europa.eu/eurostat/databrowser/product/view/rd_p_persocc?lang=en
Last update	29 March 2023
Time frequency	Annual
Time coverage	2010 – 2021
Professional position	Researchers
Unit of measure	Full-time equivalent (FTE)
Countries	EU, 27 Member States, Iceland, Montenegro, Norway, Serbia, Türkiye
Denominator	
Data source	Eurostat
Dataset	Population on 1 January by age and sex [DEMO_PJAN] https://ec.europa.eu/eurostat/databrowser/product/view/demo_pjan?lang=en
Last update	3 July 2023
Time frequency	Annual
Time coverage	2010 – 2021
Unit of measure	Number
Countries	EU, 27 Member States, Iceland, Montenegro, Norway, Serbia, Türkiye
Variable	
Data source	UNESCO Institute for Statistics (http://data.uis.unesco.org/)
Dataset	Science, technology and innovation
Last update	February 2023 edition
Time frequency	Annual
Time coverage	2015 – 2021
Unit of measure	Researchers per million inhabitants (FTE)
Countries	Georgia
No data	Armenia, Israel

Indicator #3	Share of publications available in open access
Data source	DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit based on Science-Metrix using the Scopus database and 1findrdatabases
Report	European Commission, Science, Research and Innovation Performance of the EU (SRIP) report https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/science-research-and-innovation-performance-eu-2022-report_en
Source	Figure 6.1-6 Open access scientific publications with digital object identifier (DOI) as % of total scientific publications with (DOI), 2009 and 2019
Time frequency	Annual
Time coverage	2009, 2019
Unit of measure	Percentage share
Countries	EU, 27 Member States, Iceland, Israel, Montenegro, Norway, Serbia, Türkiye
No data	Armenia, Georgia

Indicator #4	Share of national public R&D expenditure committed to joint programmes and initiatives, research infrastructures and European Partnerships
	Data for this indicator are not available and will have to be developed by the EC and the Member States

Indicator #5	Share of women in grade A positions in higher education institutes
Dataset	She Figures 2021 https://quantos-stat.shinyapps.io/GUI_SF/
Data source	Women in Science database
Option 1	Proportion (%) of women among Academic staff
Grade	A
Field of R&D	Total
Position	Academic staff
Time frequency	Annual
Time coverage	2010 – 2019
Countries	Bulgaria (9), Croatia (3), France (3), Greece (5), Germany (9), Ireland (6), Italy (9), Latvia (7), Lithuania (3), Luxembourg (1), Malta (3), Netherlands (9), Poland (7), Romania (9), Slovakia (4), Slovenia (4), Spain (9), Sweden (5), Iceland (3), Israel (5), Switzerland (9), Türkiye (3) (Number of years for which data are available)

Option 2	Proportion (%) of women among Academic staff
Grade	A
Field of R&D	Total
Position	Researchers
Time frequency	Annual
Time coverage	2010 – 2019
Countries	Austria (4), Belgium (8), Croatia (3), Cyprus (8), Denmark (9), Finland (8), France (3), Germany (2), Hungary (9), Latvia (9), Luxembourg (2), Malta (4), Poland (7), Portugal (9), Romania (5), Spain (9), Norway (8), Switzerland (9), Türkiye (3) (Number of years for which data are available)
Calculation rule #1	If available, results for Option 1 are used, otherwise, results for Option 2 are used
Calculation rule #2	The results for the EU are calculated as the unweighted average of the %-shares of all Member States for which data are available after imputing for missing data
No data	Czechia, Estonia, Armenia, Georgia, Montenegro, Serbia

Indicator #6	Job-to-job mobility of Human Resources in Science & Technology
Data source	Eurostat
Dataset	Job-to-job mobility of HRST by sex [HRST_FL_MOBSEX] https://ec.europa.eu/eurostat/databrowser/product/view/hrst_fl_mobsex?lang=en
Last update	4 February 2023
Time frequency	Annual
Time coverage	2010 – 2020
Age class	From 25 to 64 years
Unit of measure	Percentage
Countries	EU, 27 Member States, Iceland, Montenegro, Norway, Serbia, Türkiye
No data	Ireland, Armenia, Georgia, Israel

Indicator #7	Share of innovating enterprises collaborating with Higher education institutes (HEI)I and/or Public Research organisations (PRO) out of all innovative enterprises
Data source	Eurostat
Dataset	Community Innovation Survey (CIS)
Survey round	CIS 2010
Time coverage	2010
Statistical classification	Innovation core activities (Com.Reg. 1450/2004)
Size class	Total
Numerator	
Dataset	Types of co-operation partner for product and process innovation [INN_CIS7_COOP]
Type of innovator	Product and/or process innovative enterprises, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or on-going innovation activities)
Variable 1	Enterprises co-operating with government, public or private research institutes
Variable 2	Enterprises co-operating with universities or other higher education institutions
Denominator	
Dataset	Enterprises by type of innovation [INN_CIS7_TYPE]
Type of innovator	Innovative enterprises (including enterprises with abandoned/suspended or on-going innovation activities)
Survey round	CIS 2012
Time coverage	2012
Statistical classification	Innovation core activities (Com.Reg. 1450/2004)
Size class	Total
Numerator	
Dataset	Types of co-operation of the enterprises by NACE Rev. 2 activity and size class [INN_CIS8_COOP]
Type of innovator	Product and/or process innovative enterprises, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or on-going innovation activities)
Variable 1	Enterprises co-operating with clients or customers from the public sector
Variable 2	Enterprises co-operating with universities or other higher education institutions
Denominator	
Dataset	Basic economic information on the enterprises by NACE Rev. 2 activity and size class [INN_CIS8_BAS]

Type of innovator	Innovative enterprises (including enterprises with abandoned/suspended or on-going innovation activities)
Survey round	CIS 2014
Time coverage	2014
Statistical classification	Innovation core activities (Com.Reg. 995/2012)
Size class	Total
Numerator	
Dataset	Types of co-operation of the enterprises by NACE Rev. 2 activity and size class [INN_CIS9_COOP]
Type of innovator	Product and/or process innovative enterprises, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or on-going innovation activities)
Variable 1	Enterprises co-operating with clients or customers from the public sector
Variable 2	Enterprises co-operating with universities or other higher education institutions
Denominator	
Dataset	Basic economic information on the enterprises by NACE Rev. 2 activity and size class [INN_CIS9_BAS]
Type of innovator	Innovative enterprises (including enterprises with abandoned/suspended or on-going innovation activities)
Survey round	CIS 2016
Time coverage	2016
Statistical classification	Innovation core activities (Com.Reg. 995/2012)
Size class	Total
Numerator	
Dataset	Product and/or process innovative enterprises engaged in co-operation by co-operation partner, NACE Rev. 2 activity and size class [INN_CIS10_COOP]
Type of innovator	Product and/or process innovative enterprises, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or on-going innovation activities)
Variable 1	Government or public research institutes
Variable 2	Universities or other higher education institutions
Denominator	
Dataset	Basic economic information on the enterprises by NACE Rev. 2 activity and size class [INN_CIS10_BAS]
Type of innovator	Innovative enterprises
Survey round	CIS 2018

Time coverage	2018
Statistical classification	Innovation core activities (Com.Reg. 995/2012)
Size class	Total
Numerator	
Dataset	Enterprises that co-operated on R&D and other innovation activities with other enterprises or organisations, by kind and location of co-operation partner, NACE Rev. 2 activity and size class [INN_CIS11_COOP]
Type of innovator	Innovative enterprises
Variable 1	Government, public or private research institutes
Variable 2	Universities or other higher education institutions
Denominator	
Dataset	Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [INN_CIS11_BAS]
Type of innovator	Innovative enterprises
Survey round	CIS 2020
Time coverage	2020
Statistical classification	Innovation core activities (Com.Reg. 995/2012)
Size class	Total
Numerator	
Dataset	Innovative enterprises that co-operated on R&D and other innovation activities with other enterprises or organisations, by kind and location of co-operation partner, NACE Rev. 2 activity and size class [INN_CIS12_COOP]
Type of innovator	Innovative enterprises
Variable 1	Government, public or private research institutes
Variable 2	Universities or other higher education institutions
Denominator	
Dataset	Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [INN_CIS12_BAS]
Type of innovator	Innovative enterprises
Calculation rule #1	Indicator value = the highest score of the %-shares of variable 1 and variable 2 plus half of the lowest score of the %-shares of variable 1 and variable 2
Calculation rule #2	Aggregate for the EU is the sum of the numerator values divided by the sum of the denominator values for all Member States for which data are available

Countries	All years: EU, 27 MS, Iceland, Norway, Serbia, Türkiye Missing years: 2010 Greece 2012 Netherlands, Poland, Romania, Iceland 2014 Sweden 2016 Iceland 2018 Serbia 2020 Iceland, Serbia
No data	Armenia, Georgia, Israel

Indicator #8	Scientific publications among the top-10% most cited publications worldwide as a percentage of all publications
Data source	Scopus
Calculations by	Science-Metrix
Report	European Innovation Scoreboard 2023 https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en
Time frequency	Annual
Time coverage	2010-2020
Unit of measure	Percentage share
Countries	EU, 27 MS, Iceland, Israel, Montenegro, Norway, Serbia, Türkiye
No data	Armenia, Georgia

Indicator #9	International co-publications with non-EU partners per 1,000 researchers in the public sector
Data source	Scopus
Calculations by	Science-Metrix
Report	European Innovation Scoreboard 2023 https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Percentage share
Countries	EU, no data for any individual Member State or Horizon associated country
Alternative	International co-publications with foreign partners per million population
Calculations by	Science-Metrix

Report	European Innovation Scoreboard 2023 https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Percentage share
Countries	(EU), 27 MS, Iceland, Israel, Montenegro, Norway, Serbia, Türkiye
No data	Armenia, Georgia

Indicator #10	Environmentally related government R&D budget as percentage of total government R&D
Data source	OECD Green Growth Indicators Database
URL	https://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH
Last update	N/A
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Percentage
Countries	23 MS, Israel, Norway, Türkiye
No data	EU, Bulgaria, Croatia, Cyprus, Malta, Armenia, Georgia, Iceland, Montenegro, Serbia
Calculation rule for EU	1) Extract R&D spending by the government sector in million Euros from Eurostat GERD by sector of performance [RD_E_GERDTOT] Time frequency: Annual Sector of performance: Government sector Unit of measure: Million euro
	2) Calculate for each Member State Environmentally related government R&D in Euros by multiplying the percentage share from the OECD with total government R&D spending from Eurostat
	3) Aggregate for all Member States spending in Step 2 and spending in Step 3 and calculate the percentage share for the EU by dividing both aggregates and multiply by 100

Indicator #11	Share of researchers receiving transferable skills training
Data source	MORE Survey
URL	https://www.more-4.eu/online-indicator-tool
Last update	2019
Time frequency	Every 3 years
Time coverage	2016, 2019
Variable	Share of R1 (Doctoral or equivalent) researchers enrolled in a PhD programme or R2 (Post-Doctoral or equivalent) researchers with a PhD that indicate they received training in transferable skills OR developed transferable skills through work experience, in % and by country of PhD
Unit of measure	Percentage share
Countries	26 Member States, Iceland, Norway
No data	Cyprus, Armenia, Georgia, Israel, Montenegro, Serbia, Türkiye

Indicator #12	Direct government support and Indirect government support through R&D tax incentives as a percentage of GDP
Data source	OECD R&D Tax Incentives Database (http://oe.cd/rdtax)
Last update	April 2023
Time frequency	Annual
Time coverage	2010-2020
Unit of measure	Percentage share
Countries	EU, 27 Member States, Iceland, Israel, Norway, Türkiye
Calculation rule	Sum of the 2 variables: • GTARD as percentage of GDP • Direct funding of BERD as percentage of GDP
No data	Armenia, Georgia, Montenegro, Serbia
Alternative	Data on Direct funding of BERD as percentage of GDP only
Countries	Montenegro, Serbia
Source	Eurostat
Time frequency	Annual
Time coverage	2010-2020
Variable 1	R&D spending by Business enterprise sector as percentage of GDP Dataset: GERD by sector of performance [RD_E_GERDTOT]
Variable 2	R&D spending by Business enterprise sector in Million Euros Dataset: GERD by sector of performance [RD_E_GERDTOT]

Variable 3	R&D spending by Business enterprise sector funded by Government sector in Million Euros Dataset: GERD by sector of performance and source of funds [RD_E_GERDFUND]
Calculation rule	Variable 1 * Variable 3 / Variable 2
All data extracted from	European Innovation Scoreboard 2023 https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en

Indicator #13	Publications on social innovation per million population
Numerator	
Data source	OpenAIRE
URL	https://explore.openaire.eu/search/advanced/research-outcomes
Last update	Continuous
Instructions	Advanced search in 'Research products' Use two search fields: • "Any field" includes "social innovation" or • "Any field" includes "social entrepreneurship"
Time frequency	Annual
Time coverage	2010-2022
Unit of measure	Number
Countries	All
Denominator	
Data source	Eurostat
Dataset	Population on 1 January by age and sex [DEMO_PJAN] https://ec.europa.eu/eurostat/databrowser/product/view/demo_pjan?lang=en
Last update	3 July 2023
Time frequency	Annual
Time coverage	2010 – 2022
Unit of measure	Number
Countries	EU, 27 Member States, Armenia, Georgia Iceland, Montenegro, Norway, Serbia, Türkiye
Data source	World Bank
Dataset	World Development Indicators
Time frequency	Annual
Time coverage	2010 – 2021
Variable	Population, total / SP.POP.TOTL

Unit of measure	Number
Countries	Israel
Calculation rule	1,000,000 * Denominator / Numerator
Comment	Data for 2022 are not used as publication numbers are substantially below those in 2021 and most likely not all 2022 publications are covered yet in OpenAIRE

Indicator #14	Increase in total R&D expenditure in widening countries, expressed as a percentage of GDP
	For aggregate of Widening countries
Numerator	
Data source	Eurostat
Dataset	GERD by sector of performance [RD_E_GERDTOT]
Last update	9 December 2022
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Million Euro
Calculation rule for aggregate	Calculate aggregate for Widening countries as the sum of GERD in Million Euro for Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia
Denominator	
Data source	Eurostat
Dataset	GERD by sector of performance [RD_E_GERDTOT]
Last update	9 December 2022
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Percentage of gross domestic product (GDP)
Calculation rule for GDP	Calculate GDP for each country as follows: GERD in Million Euro / (GERD in Percentage of GDP / 100) / 1000
Calculation rule for aggregate	Calculate aggregate for Widening countries as the sum of GDP in Million Euro for Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia
Calculation rule for indicator	Step 1. Calculate GERD as a Percentage of GDP by dividing GERD in Million Euros for Widening countries by GDP in Million Euros for Widening countries and multiply by 100 Step 2. Calculate the indicator by taking the difference between GERD as a percentage of GDP in each year and that in the previous year
	For individual countries

Data source	Eurostat
Dataset	GERD by sector of performance [RD_E_GERDTOT]
Last update	9 December 2022
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Percentage of gross domestic product (GDP)
Calculation rule for indicator	Calculate the indicator by taking the difference between GERD as a percentage of GDP in each year and that in the previous year
Countries	27 Member States, Iceland, Montenegro, Norway, Serbia, Türkiye
Data source	OECD (https://stats.oecd.org/)
Dataset	Main Science and Technology Indicators
Last update	March 2023 edition
Time frequency	Annual
Time coverage	2010 – 2021
Unit of measure	Percentage of gross domestic product (GDP)
Calculation rule for indicator	Calculate the indicator by taking the difference between GERD as a percentage of GDP in each year and that in the previous year
Countries	Israel
Data source	UNESCO Institute for Statistics (http://data.uis.unesco.org/)
Dataset	Science, technology and innovation
Last update	February 2023 edition
Time frequency	Annual
Time coverage	2015 – 2021
Unit of measure	Percentage of gross domestic product (GDP)
Calculation rule for indicator	Calculate the indicator by taking the difference between GERD as a percentage of GDP in each year and that in the previous year
Countries	Armenia, Georgia
Comment	For individual countries, also the data used for indicator #1 – Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP – could be used.

Indicator #15	Share of Seal of Excellence rewards that received funding from other sources
Data source	Horizon Dashboard https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-dashboard
	Data are not available, but could be calculated by the Commission services using the following instructions: The indicator should measure, for each country and the EU, the share of projects with a Seal of Excellence reward that received partial or full funding from other national or international sources Aggregate data per country on projects with a Seal of Excellence reward are available from https://webgate.ec.europa.eu/dashboard/sense/app/da74e0f1-2508-4d90-a812-56891175b702/sheet/PbZJnb/state/analysis What is needed is to collect the following information for each country, where 'country' refers to having at least one consortium partner from that country: • Number of unsuccessful H2020 proposals that received a Seal of Excellence reward. • Number of such projects that received funding from other national or international sources. These data should be collected for each individual year but at least for the whole H2020 period. Most likely, the requested information will need to be collected from national sources e.g. by surveying the national consortium partner(s) of unsuccessful H2020 proposals that received a Seal of Excellence reward.

Indicator #16	Number of collaboration networks of RPOs in Widening countries with other EU countries
Data source	CORDIS Datalab https ://cordis.europa.eu/datalab/datalab.php
	Data are not available, but could be calculated by the Commission services using the following instructions: Description: The indicator should collect, for the aggregate of the Widening countries, the number of collaboration networks in these countries with other EU countries Individual data on collaborations are available from CORDIS Datalab: https://cordis.europa.eu/datalab/datalab.php What is needed is to collect aggregate data for the following: • For each of the Widening countries (Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia)

	○ X1: Number of collaborations. ○ X2: Number of collaborations involving partners in at least one other EU country. ○ X3: Number of collaborations involving partners in at least one other EU country excluding any collaborations involving a partner in at least one Widening country. • The indicator could then be constructed as, depending on the final definition: ○ Sum of X2 / Sum of X1 for all Widening countries ▪ This indicator would measure the share of collaborations with all other EU countries, irrespective if these include collaborations with other Widening countries. ○ Sum of X3 / Sum of X1 for all Widening countries ▪ This indicator would measure the share of collaborations with all other EU countries, focusing only on collaborations with partners in non-Widening countries. The requested information should be available in the raw data used for CORDIS Datalab.

Indicator #17	Share of public R&D expenditures financed by the private sector
Calculation rule	100 * Numerator / Denominator
Numerator	
Calculation rule	Sum of R&D expenditures by GOVERD funded by the business sector and R&D expenditures by HERD funded by the business sector
Data source	Eurostat
Dataset	GERD by sector of performance and source of funds [RD_E_GERDFUND]
Last update	29 March 2023
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Million Euro
Variable 1	R&D expenditures by GOVERD funded by the business sector
Sector of performance	Government sector
Sector of funds	Business enterprise sector
Variable 2	R&D expenditures by HERD funded by the business sector
Sector of performance	Higher education sector

Sector of funds	Business enterprise sector
Countries	EU, 27 Member States, Iceland, Norway, Montenegro, Serbia, Türkiye
Denominator	
Calculation rule	Sum of R&D expenditures by GOVERD and R&D expenditures by HERD
Data source	Eurostat
Dataset	GERD by sector of performance and source of funds [RD_E_GERDFUND]
Last update	29 March 2023
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Million Euro
Variable 1	R&D expenditures by GOVERD
Sector of performance	Government sector
Sector of funds	All sectors
Variable 2	R&D expenditures by HERD
Sector of performance	Higher education sector
Sector of funds	All sectors
Countries	EU, 27 Member States, Iceland, Norway, Montenegro, Serbia, Türkiye
Dataset	OECD – Main Science and Technology Indicators
Last update	March 2023
Calculation rule	100 * Numerator / Denominator
Time frequency	Annual
Time coverage	2010-2020
Numerator	
Calculation rule	Sum of R&D expenditures by GOVERD funded by the business enterprise sector and R&D expenditures by HERD funded by the business enterprise sector
Variable 1	Percentage of GOVERD financed by the business enterprise sector
Variable 2	Percentage of HERD financed by the business enterprise sector
Calculation rule #1	GOVERD financed by the business enterprise sector in million national currency = [Percentage of GOVERD financed by the business enterprise sector / 100] * [GOVERD – million national currency (for euro area: pre-EMU euro or EUR)]
Calculation rule #2	HERD financed by the business enterprise sector in million national currency = [Percentage of HERD financed by the business enterprise sector / 100] * [HERD – million national currency (for euro area: pre-EMU euro or EUR)]
Denominator	
Calculation rule	Sum of R&D expenditures by GOVERD and R&D expenditures by HERD

Variable 1	GOVERD – million national currency (for euro area: pre-EMU euro or EUR)
Variable 2	HERD – million national currency (for euro area: pre-EMU euro or EUR)
Countries	Israel
No data	Armenia, Georgia

Indicator #18	Government budget allocations for R&D (GBARD) allocated to Europe-wide transnational, as well as bilateral or multilateral, public R&D programmes per FTE researcher
Calculation rule	1,000,000 * Numerator / Denominator
Numerator	
Data source	Eurostat
Dataset	National public funding to transnationally coordinated R&D [GBA_TNCOOR]
Last update	9 February 2023
Time frequency	Annual
Time coverage	2010-2021
Unit of measure	Million Euro
Type of contri-bution recipient	Total
Type of contr-ibution recipient	Transnational public R&D performers
Calculation rule	Difference between Total and Transnational public R&D performers
Denominator	
Data source	Eurostat
Dataset	R&D personnel by sector of performance, professional position and sex [RD_P_PERSOCC]
Last update	9 December 2022
Time frequency	Annual
Time coverage	2010-2021
Sector of performance	All sectors
Professional position	Researchers
Unit of measure	Full-time equivalent (FTE)
Countries	EU, 26 Member States, Iceland, Norway, Serbia
No data	France, Armenia, Georgia, Israel, Montenegro, Türkiye

4. Imputing for missing data

The following rules are used for imputing missing data.

If data are not available at the beginning of the time series, missing values are replaced with the next available year, as shown in the following examples:

Beginning-of-period missing	2019	2020	2021	2022	2023
Available data	N/A	35	40	45	50
Substitute with next available year	35	35	40	45	50
Available data	N/A	N/A	40	45	50
Substitute with next available year	40	40	40	45	50

If data are not available at the end of the time series, missing values are replaced with the previous year, as shown in the following examples:

End-of-period missing	2019	2020	2021	2022	2023
Available data	30	35	40	45	N/A
Substitute with previous year	30	35	40	45	45
Available data	30	35	40	N/A	N/A
Substitute with previous year	30	35	40	40	40

If data for one or more years-in-between are not available, missing values are replaced such that the difference between the two years adjacent to the period for which data are not available is equally distributed over time, as shown in the following examples:

Years-in-between missing	2019	2020	2021	2022	2023
Available data	30	N/A	40	45	50
Substitute with average of surrounding years	30	35	40	45	50
Available data	30	N/A	N/A	45	50
Substitute with average of surrounding years	30	35	40	45	50

5. Measuring performance differences over time

The ERA Scoreboard uses different metrics to assess if performance differences between Member States have become smaller over time:

- The variance and the standard deviation are measures of the spread of the data around the mean. Both metrics summarise how close each observed data value is to the mean value. The smaller the variance and standard deviation, the more the mean value is indicative of the whole dataset.

  Therefore, if all values of a dataset are the same, the standard deviation and variance are zero. Variance is calculated as the sum of the squared deviations of the score of each Member State with the mean score across all Member States. The standard deviation is calculated as the square root of the variance.

- Range. The difference between the second highest and second lowest score across the Member States.

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Within the context of the ERA Monitoring Mechanism, this report presents the methodology used in the ERA Scoreboard 2023. In particular, it provides detailed information on the indicator framework, the indicator definitions and data sources, and on what rules are used for imputing missing data.

Research and Innovation policy