



The 19th International Scientific Conference
**“DEFENSE RESOURCES MANAGEMENT
IN THE 21st CENTURY”**
Braşov, November 7th-8th 2024



**HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY
IN EU COUNTRIES – AN OVERVIEW**

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Abstract: In this paper we have analyzed the evolution of the human resources in science and technology (HRST) in EU Countries. This evolution is important for the high-tech industry and knowledge-intensive services, both being part of the Science, Technology and Digital Society branch in the EUROSTAT Database. We studied the absolute chain increment for each country emphasizing the minimum and the maximum values.

Key words: indicator; evolution; absolute chain increment; HRST; EU Countries; trend; education.

1. Introduction

Human Resources in Science and Technology (HRST) encompasses two main categories: people with tertiary education and those working in science and technology jobs that typically require this level of education. HRST is defined by either educational achievement (completion of tertiary education) or occupation (working in science and technology roles that usually demand tertiary-level qualifications), regardless of current job title. The HRST concept covers both individuals who have completed tertiary education and those employed in science and technology positions where such qualifications are typically required, focusing primarily on educational attainment rather than current occupation.

To better study the evolution of people who are part of HRST, we calculated the absolute chain increment over 10 years for EU countries. The formula used was:

$$\Delta Y = Y_i - Y_{i-1} \quad (1)$$

In the tables below the countries are presented using the two letters abbreviation, as follows: EU-27 (European Union 27 countries), AT (Austria), BE (Belgium), BG (Bulgaria), CY (Cyprus), CZ (Czechia), DE (Germany), DK (Denmark), EE (Estonia), EL (Greece), ES (Spain), FI (Finland) FR (France), HR (Croatia), HU (Hungary), IE (Ireland), IT (Italy), LT (Lithuania), LU (Luxembourg), LV (Latvia), MT (Malta), NL (Netherlands), PL (Poland), PT (Portugal), RO (Romania), SE (Sweden), SI (Slovenia), SK (Slovakia).

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

2. Data analysis

2.1. Persons with tertiary education (ISCED) and/or employed in science and technology

The first indicator analyzed is the absolute chain increment of the persons with tertiary education and/or employed in science and technology.

In EU-27, the smallest increase of this indicator was in 2020 compared to 2019 (780.9 thousand people), while the highest increase was in 2023 compared to 2022 (2,859.4 thousand people), in Austria the smallest increase was in 2020 compared to 2019 – 27.3 thousand people and the highest increase was in 2022 compared to 2021 – 91.8 thousand people.

We will now present the maximum and minimum values for all 27 EU countries, separated in 4 tables. We note that the negative values show a decrease in the number of people.

Belgium: -22.3 thousand people in 2015 compared to 2014 and 154.6 thousand people in 2017 compared to 2016 (Table 1a); Bulgaria: -62.2 thousand people in 2019 compared to 2018 and 35.1 thousand people in 2015 compared to 2014; Cyprus: -2 thousand people in 2015 compared to 2014 and 25.7 thousand people in 2023 compared to 2022; Czechia: -38.4 thousand people in 2022 compared to 2021 and 74.2 thousand people in 2021 compared to 2020; Deutschland -233.3 thousand people in 2020 compared to 2019 and 686.6 thousand people in 2016 compared to 2015.

Absolute chain increment	EU-27	AT	BE	BG	CY	CZ	DE
y2015 - y2014	2024.2	44.5	-22.3	35.1	-2	9.5	414.4
y2016 - y2015	2246.8	65.9	38.9	-2	5.1	59.5	686.6
y2017 - y2016	2268.7	55.2	154.6	21.5	7.9	69.5	311.6
y2018 - y2017	2218.1	30.1	50.2	12.1	11.6	41.4	320.6
y2019 - y2018	2572.3	50.2	37.7	-62.2	9.7	-8	638.9
y2020 - y2019	780.9	27.3	94.9	13.6	1.8	23.6	-233.3
y2021 - y2020	2359.1	29.7	133	2.6	15.4	74.2	448.3
y2022 - y2021	2722	91.8	90.4	2.3	13.6	-38.4	399.6
y2023 - y2022	2859.4	72.2	-17.8	17.5	25.7	-0.2	633.1

Table 1a The evolution of number of persons with tertiary education (ISCED) and/or employed in science and technology (thousand persons; from 15 to 74 years; EU-27 – DE)

For the second group of countries, the minimum and maximum values of the absolute chain increment are as follows (Table 1b): Denmark: 12.4 thousand people in 2020 compared to 2019 and 56.7 thousand people in 2017 compared to 2016; Estonia: -3.8 thousand people in 2015 compared to 2014 and 16 thousand people in 2019 compared to 2018; Greece: -11.3 thousand people in 2023 compared to 2022 and 107.7 thousand people in 2022 compared to 2021; Spain: 25.7 thousand people in 2020 compared to 2019 and 409.2 thousand people in 2023 compared to 2022; Finland: -86.7 thousand people in 2021 compared to 2020 and 56.2 thousand people in 2018 compared to 2017; France: 175.3 thousand people in 2017 compared to 2016 and 461.5 thousand people in 2023 compared to 2022; Croatia: -24.5 thousand people in 2019 compared to 2018 and 51.2 thousand people in 2023 compared to 2022.

Absolute chain increment	DK	EE	EL	ES	FI	FR	HR
y2015 - y2014	29.5	-3.8	29.4	240.1	12.9	268.1	19.7
y2016 - y2015	35.5	4.1	80.8	260.2	12.5	245.3	2.3
y2017 - y2016	56.7	11.8	56.7	309.9	36.4	175.3	21.9
y2018 - y2017	39.9	7.2	51.2	299.9	56.2	366	27.6
y2019 - y2018	35.1	16	40.5	369.1	39.6	353.2	-24.5
y2020 - y2019	12.4	-0.3	22.8	25.7	37.1	329.5	0.6
y2021 - y2020	39.4	15.3	84.6	383.8	-86.7	334.9	-2.1

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

y2022 - y2021	43	12	107.7	382.8	36.4	437.8	2.5
y2023 - y2022	33.9	8.7	-11.3	409.2	16	461.5	51.2

Table 1b The evolution of number of persons with tertiary education (ISCED) and/or employed in science and technology (thousand persons; from 15 to 74 years; DK – HR)

For the third group of countries (Table 1c), the indicator has the following minimum and maximum values: Hungary: 17.2 thousand people in 2017 compared to 2016 and 146 thousand people in 2021 compared to 2020; Ireland: 28.6 thousand people in 2018 compared to 2017 and 124.4 thousand people in 2021 compared to 2020; Italia: -212.6 thousand people in 2021 compared to 2020 and 512 thousand people in 2023 compared to 2022; Lithuania: -4.9 thousand people in 2017 compared to 2016 and 50.4 thousand people in 2022 compared to 2021; Luxembourg: -8.2 thousand people in 2015 compared to 2014 and 16 thousand people in 2021 compared to 2020; Latvia: -5.8 thousand people in 2023 compared to 2022 and 19.3 thousand people in 2015 compared to 2014; Malta: 4.4 thousand people in 2016 compared to 2015 and 13.4 thousand people in 2018 compared to 2017.

Absolute chain increment	HU	IE	IT	LT	LU	LV	MT
y2015 - y2014	39.7	41.4	163.7	25.6	-8.2	19.3	4.8
y2016 - y2015	25.9	39	146.4	13.7	5.1	5.6	4.4
y2017 - y2016	17.2	60.1	249.5	-4.9	0.7	7.4	9.3
y2018 - y2017	47.8	28.6	157.4	17.7	14.2	4.4	13.4
y2019 - y2018	56.8	45.9	95.8	24.3	13.2	18.2	8.7
y2020 - y2019	67.3	45.7	-115.6	2.2	5.9	1.3	5.7
y2021 - y2020	146	124.4	-212.6	21.4	16	-3.5	7.2
y2022 - y2021	44.4	97.3	221.4	50.4	7.5	13	6.4
y2023 - y2022	32.8	63.1	512	23.6	3.9	-5.8	9.3

Table 1c The evolution of number of persons with tertiary education (ISCED) and/or employed in science and technology (thousand persons; from 15 to 74 years; HU – MT)

The minimum and maximum values of the absolute chain increment indicator for the fourth group of countries (Table 1d) are as follows: Netherlands: 70.3 thousand people in 2023 compared to 2022 and 334.3 thousand people in 2021 compared to 2020; Poland: 96.3 thousand people in 2022 compared to 2021 and 547.5 thousand people in 2023 compared to 2022; Portugal: 20.8 thousand people in 2023 compared to 2022 and 110.1 thousand people in 2021 compared to 2020; Romania: -139.9 thousand people in 2023 compared to 2022 and 122.1 thousand people in 2015 compared to 2014; Sweden: 24.8 thousand people in 2021 compared to 2020 and 127.5 thousand people in 2022 compared to 2021; Slovenia: -62.2 thousand people in 2023 compared to 2022 and 41 thousand people in 2021 compared to 2020; Slovakia: -5.8 thousand people in 2023 compared to 2022 and 76.9 thousand people in 2021 compared to 2020.

Absolute chain increment	NL	PL	PT	RO	SE	SI	SK
y2015 - y2014	83.3	237.4	91.1	122.1	87.3	13.4	28.6
y2016 - y2015	94	161.7	74.1	27.6	115.3	10.3	28.8
y2017 - y2016	123.5	249.2	58.7	59.2	89	24.1	37
y2018 - y2017	177.4	192.8	75.8	14.3	104.3	8	47.7
y2019 - y2018	224.7	382.9	59.7	32.1	65.1	10.3	39.4
y2020 - y2019	186	114.7	35.7	-9.6	37.3	26.4	22.5
y2021 - y2020	334.3	197.5	110.1	2.7	24.8	41	76.9
y2022 - y2021	248.3	96.3	76.5	111	127.5	-2.2	43.2
y2023 - y2022	70.3	547.5	20.8	-139.9	89.7	-62.2	-5.8

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

Table 1d The evolution of number of persons with tertiary education (ISCED) and/or employed in science and technology (thousand persons; from 15 to 74 years; NL – SK)

2.2. Persons with tertiary education (ISCED)

The second indicator analyzed is the absolute chain increment for the number of persons with tertiary education employed in science and technology. In Table 2a we can find the next values – minimum and maximum: EU-27: 1437.4 thousand people in 2020 compared to 2019 and 2604.4 thousand people in 2021 compared to 2020; Austria: 12.4 thousand people in 2020 compared to 2019 and 69.8 thousand people in 2022 compared to 2021; Belgium: -32.5 thousand people in 2023 compared to 2022 and 151.9 thousand people in 2021 compared to 2020; Bulgaria: -51.2 thousand people in 2019 compared to 2018 and 31.9 thousand people in 2015 compared to 2014; Cyprus: -1.8 thousand people in 2015 compared to 2014 and 23.9 thousand people in 2023 compared to 2022; Czechia: -20.5 thousand people in 2023 compared to 2022 and 90.5 thousand people in 2021 compared to 2020; Deutschland: 205.7 thousand people in 2017 compared to 2016 and 574.5 thousand people in 2023 compared to 2022.

Absolute chain increment	EU-27	AT	BE	BG	CY	CZ	DE
y2015 - y2014	1924.1	45.6	1.4	31.9	-1.8	39.6	333.7
y2016 - y2015	1891.6	67.5	46.8	1.5	5.1	54.7	510.2
y2017 - y2016	2045.7	49.3	142.1	9.9	6.9	51.7	205.7
y2018 - y2017	2094.2	22.2	59.5	7.3	11.9	32.8	211.8
y2019 - y2018	2434.7	55.6	20.7	-51.2	9.7	-17.4	476
y2020 - y2019	1437.4	12.4	94.6	20.6	2.4	11.3	226.2
y2021 - y2020	2604.4	31.2	151.9	11.9	14.4	90.5	505.5
y2022 - y2021	2196	69.8	84.8	5.1	13.1	-7.4	217.8
y2023 - y2022	2467.7	67.2	-32.5	13.9	23.9	-20.5	574.5

Table 2a The evolution of number of persons with tertiary education (ISCED) (thousand persons; from 15 to 74 years; EU-27 – DE)

In Table 2b we can distinguish the next minimum and maximum values: Denmark: 17.1 thousand people in 2020 compared to 2019 and 41.5 thousand people in 2019 compared to 2018; Estonia: -3.2 thousand people in 2020 compared to 2019 and 12.4 thousand people in 2021 compared to 2020; Greece: -29.3 thousand people in 2023 compared to 2022 and 87.5 thousand people in 2021 compared to 2020; Spain: 71.1 thousand people in 2020 compared to 2019 and 380.6 thousand people in 2021 compared to 2020; Finland: -119.1 thousand people in 2021 compared to 2020 and 45 thousand people in 2018 compared to 2017; France: 224.2 thousand people in 2017 compared to 2016 and 552.9 thousand people in 2021 compared to 2020; Croatia: -25.8 thousand people in 2019 compared to 2018 and 52.2 thousand people in 2023 compared to 2022.

Absolute chain increment	DK	EE	EL	ES	FI	FR	HR
y2015 - y2014	41.1	-2.6	36.8	194.5	15.5	272	23.9
y2016 - y2015	23.5	4.4	67.3	241.7	9.1	284.1	5.2
y2017 - y2016	32.9	7.8	52.5	271.5	30.5	224.2	19.1
y2018 - y2017	37.2	2.6	61.7	298.4	45	441.4	28.4
y2019 - y2018	41.5	9	33.8	367.1	35	409.1	-25.8
y2020 - y2019	17.1	-3.2	18.7	71.1	37.4	389.8	6.1
y2021 - y2020	40	12.4	87.5	380.6	-119.1	552.9	2.8
y2022 - y2021	35.6	11.9	81.9	337.3	26.8	387.5	6.6
y2023 - y2022	37	8.3	-29.3	359.4	5.3	328.9	52.2

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

Table 2b The evolution of number of persons with tertiary education (ISCED)
(thousand persons; from 15 to 74 years; DK – HR)

In Table 2c we have the following minimum and maximum values: Hungary: 5 thousand people in 2016 compared to 2015 and 163.3 thousand people in 2021 compared to 2020; Ireland: 27.1 thousand people in 2018 compared to 2017 and 113.4 thousand people in 2021 compared to 2020; Italia: 0.1 thousand people in 2020 compared to 2019 and 396.9 thousand people in 2023 compared to 2022; Lithuania: -1.7 thousand people in 2017 compared to 2016 and 43.4 thousand people in 2022 compared to 2021; Luxembourg: -11 thousand people in 2017 compared to 2016 and 29.9 thousand people in 2018 compared to 2017; Latvia: -1 thousand people in 2023 compared to 2022 and 16.6 thousand people in 2016 compared to 2015; Malta: 2.7 thousand people in 2016 compared to 2015 and 10.4 thousand people in 2018 compared to 2017.

Absolute chain increment	HU	IE	IT	LT	LU	LV	MT
y2015 - y2014	45.3	49.1	190.6	26.2	-10.6	13.8	2.9
y2016 - y2015	5	27.4	119.5	16.8	-0.7	16.6	2.7
y2017 - y2016	6.7	57.3	314.3	-1.7	-11	1.5	7
y2018 - y2017	53.1	27.1	175.2	17.4	29.9	6.3	10.4
y2019 - y2018	42.7	27.7	101.5	28.7	14.8	13.3	8
y2020 - y2019	48.4	54.4	0.1	4.6	3	6.4	6.3
y2021 - y2020	163.3	113.4	49.1	16	16.6	2.1	5
y2022 - y2021	25.8	94.7	127.9	43.4	9.3	7.2	4.2
y2023 - y2022	17.1	54.1	396.9	8.3	4.5	-1	9.6

Table 2c The evolution of number of persons with tertiary education (ISCED)
(thousand persons; from 15 to 74 years; HU – MT)

Table 2d show us the next minimum and maximum values: Netherlands: 23.8 thousand people in 2023 compared to 2022 and 204.7 thousand people in 2022 compared to 2021; Poland: 91.7 thousand people in 2022 compared to 2021 and 650.6 thousand people in 2023 compared to 2022 Portugal: 32.6 thousand people in 2020 compared to 2019 and 105.3 thousand people in 2021 compared to 2020; Romania: -127.3 thousand people in 2023 compared to 2022 and 135.7 thousand people in 2015 compared to 2014; Sweden: 24.9 thousand people in 2020 compared to 2019 and 121.6 thousand people in 2022 compared to 2021; Slovenia: -59.1 thousand people in 2023 compared to 2022 and 36.1 thousand people in 2021 compared to 2020; Slovakia: -5.2 thousand people in 2023 compared to 2022 and 62.4 thousand people in 2021 compared to 2020.

Absolute chain increment	NL	PL	PT	RO	SE	SI	SK
y2015 - y2014	84	176.5	61.1	135.7	71.9	17.3	28.4
y2016 - y2015	55.6	123.9	59.3	11.6	97.9	8.1	27.2
y2017 - y2016	134.3	224.8	41.3	42.2	63	24.2	37.5
y2018 - y2017	128.4	167.7	73.6	4	93.8	5.8	41.2
y2019 - y2018	193	390.9	73.3	57.7	66.1	11.7	42.3
y2020 - y2019	200.8	121.2	32.6	-12.8	24.9	30.1	13
y2021 - y2020	118.8	93	105.3	-23	83.9	36.1	62.4
y2022 - y2021	204.7	91.7	73	77.6	121.6	-1.4	45.2
y2023 - y2022	23.8	650.6	38.4	-127.3	68.8	-59.1	-5.2

Table 2d The evolution of number of persons with tertiary education (ISCED)
(thousand persons; from 15 to 74 years; NL – SK)

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

2.3. Persons employed in science and technology

The third indicator analyzed is the absolute chain increment of the persons employed in science and technology in tables 3a to 3d. The minimum and the maximum values are as follows: EU-27: 247.7 thousand people in 2020 compared to 2019 and 2344 thousand people in 2023 compared to 2022; Austria: 16.2 thousand people in 2019 compared to 2018 and 62.5 thousand people in 2023 compared to 2022; Belgium: -9.6 thousand people in 2015 compared to 2014 and 115.1 thousand people in 2017 compared to 2016; Bulgaria: -34 thousand people in 2019 compared to 2018 and 31.9 thousand people in 2015 compared to 2014; Cyprus: -2.9 thousand people in 2015 compared to 2014 and 20.1 thousand people in 2023 compared to 2022; Czechia: -45.7 thousand people in 2022 compared to 2021 and 61.9 thousand people in 2017 compared to 2016; Deutschland: -769.3 thousand people in 2020 compared to 2019 and 718.1 thousand people in 2021 compared to 2020.

Absolute chain increment	EU-27	AT	BE	BG	CY	CZ	DE
y2015 - y2014	1445.7	22.9	-9.6	31.9	-2.9	-6.6	360.4
y2016 - y2015	1702.9	34.9	21.8	-0.2	-0.4	50.5	507.6
y2017 - y2016	1520.1	42.7	115.1	10.9	7.9	61.9	233.2
y2018 - y2017	1547.7	39.8	34.2	13.9	6.7	34	262.6
y2019 - y2018	1924.5	16.2	25	-34	3.4	-4.3	503.4
y2020 - y2019	247.7	32.8	67	20	2.8	40.1	-769.3
y2021 - y2020	2100.6	21.1	58	12.3	13.8	46	718.1
y2022 - y2021	1782.9	60.2	50.1	-10.8	8.7	-45.7	328
y2023 - y2022	2344	62.5	-0.2	16.7	20.1	15.7	463

Table 3a The evolution of number of persons employed in science and technology (thousand persons; from 15 to 74 years; EU-27 – DE)

From Table 3b we extracted the minimum and the maximum values: Denmark: -3.9 thousand people in 2021 compared to 2020 and 44.7 thousand people in 2022 compared to 2021; Estonia: -3.7 thousand people in 2015 compared to 2014 and 21.7 thousand people in 2021 compared to 2020; Greece: 7.8 thousand people in 2023 compared to 2022 and 68.6 thousand people in 2022 compared to 2021; Spain: 74.5 thousand people in 2020 compared to 2019 and 317.3 thousand people in 2023 compared to 2022; Finland: -74.4 thousand people in 2021 compared to 2020 and 56.4 thousand people in 2020 compared to 2019; France: 80.6 thousand people in 2017 compared to 2016 and 513.3 thousand people in 2023 compared to 2022; Croatia: -16 thousand people in 2019 compared to 2018 and 40.2 thousand people in 2023 compared to 2022.

Absolute chain increment	DK	EE	EL	ES	FI	FR	HR
y2015 - y2014	7.6	-3.7	17	138.3	1.8	198	6.3
y2016 - y2015	28.3	4.6	43.2	216.2	7	181	1.7
y2017 - y2016	44.5	13.5	19.2	158.5	37.5	80.6	17.1
y2018 - y2017	38.2	6.7	14.2	153.5	43.3	191.1	19.8
y2019 - y2018	24.3	12.9	22.6	272.4	41	195.8	-16
y2020 - y2019	17.9	3.8	47.3	74.5	56.4	236.3	4
y2021 - y2020	-3.9	21.7	21.4	190.3	-74.4	459	-7.4
y2022 - y2021	44.7	7.2	68.6	198.1	39.5	249.4	-0.9
y2023 - y2022	28.1	7.3	7.8	317.3	11.8	513.3	40.2

Table 3b The evolution of number of persons employed in science and technology (thousand persons; from 15 to 74 years; DK – HR)

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

Next minimum and maximum values of this indicator are in Table 3c and are as follows: Hungary: 13.9 thousand people in 2022 compared to 2021 and 105.7 thousand people in 2021 compared to 2020; Ireland: 19.8 thousand people in 2018 compared to 2017 and 78.3 thousand people in 2021 compared to 2020; Italia: -281.1 thousand people in 2021 compared to 2020 and 422.5 thousand people in 2023 compared to 2022; Lithuania: -6.8 thousand people in 2015 compared to 2014 and 36.2 thousand people in 2022 compared to 2021; Luxembourg: -6.2 thousand people in 2015 compared to 2014 and 10.2 thousand people in 2018 compared to 2017; Latvia: -10.9 thousand people in 2023 compared to 2022 and 16.6 thousand people in 2015 compared to 2014; Malta: 3.1 thousand people in 2021 compared to 2020 and 7.9 thousand people in 2018 compared to 2017.

Absolute chain increment	HU	IE	IT	LT	LU	LV	MT
y2015 - y2014	19.4	26.2	79.7	-6.8	-6.2	16.6	4.1
y2016 - y2015	21.5	30.2	133.5	8.4	1.7	7.6	3.5
y2017 - y2016	21.9	26.2	141.2	-5.1	3.4	-0.7	5.3
y2018 - y2017	27.7	19.8	93.1	9.1	10.2	-6.6	7.9
y2019 - y2018	69.6	37.8	102.7	7.5	9.3	13.2	6.1
y2020 - y2019	79.3	34.2	-95.9	10.5	7.1	7.5	4.3
y2021 - y2020	105.7	78.3	-281.1	23.3	10	-7	3.1
y2022 - y2021	13.9	54.2	110	36.2	4.2	13.8	4.3
y2023 - y2022	16.5	47.4	422.5	27.1	8.3	-10.9	4.1

Table 3c The evolution of number of persons employed in science and technology (thousand persons; from 15 to 74 years; HU – MT)

Table 3d shows the next minimum and maximum values: Netherlands: 63.3 thousand people in 2017 compared to 2016 and 340.2 thousand people in 2021 compared to 2020; Poland: 22.7 thousand people in 2022 compared to 2021 and 299.3 thousand people in 2023 compared to 2022; Portugal: -13.7 thousand people in 2023 compared to 2022 and 85.2 thousand people in 2015 compared to 2014; Romania: -77.9 thousand people in 2023 compared to 2022 and 79.1 thousand people in 2015 compared to 2014; Sweden: 2.5 thousand people in 2021 compared to 2020 and 116 thousand people in 2022 compared to 2021; Slovenia: -50.9 thousand people in 2023 compared to 2022 and 47 thousand people in 2021 compared to 2020; Slovakia: 0.6 thousand people in 2023 compared to 2022 and 44.5 thousand people in 2021 compared to 2020.

Absolute chain increment	NL	PL	PT	RO	SE	SI	SK
y2015 - y2014	88.4	214.3	85.2	79.1	75.3	3.7	5.2
y2016 - y2015	134.7	60.9	50.1	39.7	90	8.7	16.4
y2017 - y2016	63.3	195.4	52.2	62.4	66.7	21.8	23.4
y2018 - y2017	178.2	178.3	52.6	5.6	81.9	5.1	26.8
y2019 - y2018	157.6	293.1	20.6	43.2	62.3	8	30.5
y2020 - y2019	147.6	101.3	64.8	-26.2	46.5	17.6	16.1
y2021 - y2020	340.2	183.6	53.6	20.5	2.5	47	44.5
y2022 - y2021	244.5	22.7	62.5	69.5	116	-0.1	34
y2023 - y2022	80.7	299.3	-13.7	-77.9	87.6	-50.9	0.6

Table 3d The evolution of number of persons employed in science and technology (thousand persons; from 15 to 74 years; NL – SK)

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

2.4. Persons with tertiary education (ISCED) and employed in science and technology

The fourth indicator analyzed is the absolute chain increment for the number of persons with tertiary education and employed in science and technology. The minimum and maximum values for each country are presented in Tables 4a to 4d: EU-27: 904.1 thousand people in 2020 compared to 2019 and 2345.9 thousand people in 2021 compared to 2020; Austria: 17.8 thousand people in 2020 compared to 2019 and 57.5 thousand people in 2023 compared to 2022; Belgium: -14.9 thousand people in 2023 compared to 2022 and 102.8 thousand people in 2017 compared to 2016; Bulgaria: -23 thousand people in 2019 compared to 2018 and 28.6 thousand people in 2015 compared to 2014; Cyprus: -2.7 thousand people in 2015 compared to 2014 and 18.3 thousand people in 2023 compared to 2022; Czechia: -14.7 thousand people in 2022 compared to 2021 and 62.3 thousand people in 2021 compared to 2020; Deutschland: -309.9 thousand people in 2020 compared to 2019 and 775.4 thousand people in 2021 compared to 2020.

Absolute chain increment	EU-27	AT	BE	BG	CY	CZ	DE
y2015 - y2014	1345.6	24	14	28.6	-2.7	23.5	279.8
y2016 - y2015	1347.8	36.5	29.6	3.5	-0.4	45.7	331.2
y2017 - y2016	1297	36.8	102.8	-0.9	7	44.1	127.3
y2018 - y2017	1423.7	31.9	43.4	9.2	6.9	25.5	153.8
y2019 - y2018	1787.1	21.6	8.1	-23	3.5	-13.7	340.5
y2020 - y2019	904.1	17.8	66.6	27	3.4	27.7	-309.9
y2021 - y2020	2345.9	22.7	76.9	21.6	12.7	62.3	775.4
y2022 - y2021	1257	38.1	44.6	-7.9	8.2	-14.7	146.1
y2023 - y2022	1952.2	57.5	-14.9	13	18.3	-4.6	404.5

Table 4a The evolution of number of persons with tertiary education (ISCED) and employed in science and technology (thousand persons; from 15 to 74 years; EU-27 – DE)

The minimum and maximum values for the next countries are: Denmark: -3.3 thousand people in 2021 compared to 2020 and 37.5 thousand people in 2022 compared to 2021; Estonia: -2.5 thousand people in 2015 compared to 2014 and 18.9 thousand people in 2021 compared to 2020;

Greece: -10.1 thousand people in 2023 compared to 2022 and 43.2 thousand people in 2020 compared to 2019; Spain: 92.7 thousand people in 2015 compared to 2014 and 270.5 thousand people in 2019 compared to 2018; Finland: -106.8 thousand people in 2021 compared to 2020 and 56.7 thousand people in 2020 compared to 2019; France: 129.6 thousand people in 2017 compared to 2016 and 677 thousand people in 2021 compared to 2020; Croatia: -17.5 thousand people in 2019 compared to 2018 and 41.2 thousand people in 2023 compared to 2022.

Absolute chain increment	DK	EE	EL	ES	FI	FR	HR
y2015 - y2014	19.2	-2.5	24.6	92.7	4.4	201.8	10.5
y2016 - y2015	16.3	4.8	29.5	197.7	3.4	219.8	4.6
y2017 - y2016	20.8	9.6	15.1	120.1	31.7	129.6	14.3
y2018 - y2017	35.3	2	24.7	152	32	266.6	20.7
y2019 - y2018	30.8	6	15.9	270.5	36.5	251.6	-17.5
y2020 - y2019	22.5	0.8	43.2	119.8	56.7	296.6	9.7
y2021 - y2020	-3.3	18.9	24.2	187.1	-106.8	677	-2.6
y2022 - y2021	37.5	7.2	42.9	152.6	29.9	199.1	3.2
y2023 - y2022	31.1	6.7	-10.1	267.5	1	380.6	41.2

Table 4b The evolution of number of persons with tertiary education (ISCED) and employed in science and technology (thousand persons; from 15 to 74 years; DK – HR)

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

Table 4c shows the following minimum and maximum values: Hungary: -4.8 thousand people in 2022 compared to 2021 and 123.1 thousand people in 2021 compared to 2020; Ireland: 18.3 thousand people in 2018 compared to 2017 and 67.3 thousand people in 2021 compared to 2020; Italia: -19.5 thousand people in 2021 compared to 2020 and 307.3 thousand people in 2023 compared to 2022; Lithuania: -6.1 thousand people in 2015 compared to 2014 and 29.4 thousand people in 2022 compared to 2021; Luxembourg: -8.6 thousand people in 2015 compared to 2014 and 26 thousand people in 2018 compared to 2017; Latvia: -6.7 thousand people in 2017 compared to 2016 and 18.6 thousand people in 2016 compared to 2015; Malta: 0.9 thousand people in 2021 compared to 2020 and 5.4 thousand people in 2019 compared to 2018.

Absolute chain increment	HU	IE	IT	LT	LU	LV	MT
y2015 - y2014	25.1	33.9	106.6	-6.1	-8.6	11	2.4
y2016 - y2015	0.4	18.5	106.7	11.4	-4.1	18.6	1.8
y2017 - y2016	11.5	23.5	206	-1.8	-8.4	-6.7	2.9
y2018 - y2017	33	18.3	110.8	8.7	26	-4.7	4.9
y2019 - y2018	55.5	19.6	108.4	12	10.8	8.4	5.4
y2020 - y2019	60.4	42.9	19.8	12.8	4.2	12.6	4.9
y2021 - y2020	123.1	67.3	-19.5	17.8	10.6	-1.4	0.9
y2022 - y2021	-4.8	51.6	16.6	29.4	6.1	8.1	2.1
y2023 - y2022	0.7	38.4	307.3	11.7	8.9	-6.2	4.4

Table 4c The evolution of number of persons with tertiary education (ISCED) and employed in science and technology (thousand persons; from 15 to 74 years; HU – MT)

In Table 4d we can find the next minimum and maximum values: Netherlands: 34.2 thousand people in 2023 compared to 2022 and 200.8 thousand people in 2022 compared to 2021; Poland: 18.1 thousand people in 2022 compared to 2021 and 402.3 thousand people in 2023 compared to 2022; Portugal: 3.7 thousand people in 2023 compared to 2022 and 61.6 thousand people in 2020 compared to 2019; Romania: -65.3 thousand people in 2023 compared to 2022 and 92.7 thousand people in 2015 compared to 2014; Sweden: 34 thousand people in 2020 compared to 2019 and 110 thousand people in 2022 compared to 2021; Slovenia: -48 thousand people in 2023 compared to 2022 and 42 thousand people in 2021 compared to 2020; Slovakia: 1.3 thousand people in 2023 compared to 2022 and 36 thousand people in 2022 compared to 2021.

Absolute chain increment	NL	PL	PT	RO	SE	SI	SK
y2015 - y2014	89.1	153.4	55.2	92.7	60	7.7	5.1
y2016 - y2015	96.3	23.2	35.3	23.7	72.6	6.6	14.7
y2017 - y2016	74.2	171	34.8	45.4	40.7	21.8	23.9
y2018 - y2017	129.2	153.1	50.3	-4.7	71.5	2.8	20.4
y2019 - y2018	125.8	301.1	34.3	68.8	63.2	9.5	33.4
y2020 - y2019	162.4	107.9	61.6	-29.4	34	21.3	6.6
y2021 - y2020	124.8	79.1	48.8	-5.2	61.8	42	29.9
y2022 - y2021	200.8	18.1	59.2	36.1	110	0.9	36
y2023 - y2022	34.2	402.3	3.7	-65.3	66.7	-48	1.3

Table 4d The evolution of number of persons with tertiary education (ISCED) and employed in science and technology (thousand persons; from 15 to 74 years; NL – SK)

2.5. Scientists and engineers

The fifth and last indicator analyzed is the absolute chain increment for the number of scientists and engineers employed in science and technology. The minimum and the maximum values for the first group of countries are as follows (Table 1a): EU-27: 298.5 thousand people in

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

2015 compared to 2014 and 1175.3 thousand people in 2021 compared to 2020; Austria: -2.2 thousand people in 2019 compared to 2018 and 119.7 thousand people in 2018 compared to 2017; Belgium: -5.5 thousand people in 2023 compared to 2022 and 40.7 thousand people in 2017 compared to 2016; Bulgaria: -9.9 thousand people in 2019 compared to 2018 and 14.3 thousand people in 2022 compared to 2021; Cyprus: 0.2 thousand people in 2016 compared to 2015 and 7.3 thousand people in 2023 compared to 2022; Czechia: 2.4 thousand people in 2017 compared to 2016 and 21.4 thousand people in 2021 compared to 2020; Deutschland: 5 thousand people in 2018 compared to 2017 and 295 thousand people in 2021 compared to 2020.

Absolute chain increment	EU-27	AT	BE	BG	CY	CZ	DE
y2015 - y2014	298.5	19.7	16.4	9.2	0.8	19.5	87.8
y2016 - y2015	490.4	10.1	32.4	-3.2	0.2	8.5	169.7
y2017 - y2016	420.2	11.1	40.7	4.1	3.9	2.4	54
y2018 - y2017	570.8	119.7	7.1	9.6	1.3	14	5
y2019 - y2018	700.5	-2.2	15.1	-9.9	0.5	14.7	94.5
y2020 - y2019	614.3	5.9	16.5	9	0.6	18.8	74.3
y2021 - y2020	1175.3	14.7	30.2	-2.8	5	21.4	295
y2022 - y2021	612.9	22.5	-2.4	14.3	7.2	6.3	68.5
y2023 - y2022	882.1	16.1	-5.5	13.8	7.3	15.6	158.5

Table 5a The evolution of number of scientists and engineers
(thousand persons; from 15 to 74 years; EU-27 – DE)

For the next group of countries the minimum and maximum values of the indicator are (Table 5b): Denmark: -1.5 thousand people in 2015 compared to 2014 and 16.9 thousand people in 2016 compared to 2015; Estonia: 0.3 thousand people in 2017 compared to 2016 and 7.7 thousand people in 2022 compared to 2021; Greece: -3.1 thousand people in 2015 compared to 2014 and 49.5 thousand people in 2022 compared to 2021; Spain: 19.5 thousand people in 2015 compared to 2014 and 152.8 thousand people in 2023 compared to 2022; Finland: -31.1 thousand people in 2021 compared to 2020 and 33 thousand people in 2020 compared to 2019; France: -15.3 thousand people in 2015 compared to 2014 and 443.6 thousand people in 2021 compared to 2020; Croatia: -5.4 thousand people in 2015 compared to 2014 and 14.6 thousand people in 2018 compared to 2017.

Absolute chain increment	DK	EE	EL	ES	FI	FR	HR
y2015 - y2014	-1.5	3.8	-3.1	19.5	6.8	-15.3	-5.4
y2016 - y2015	16.9	2	21.1	70.9	2.2	48.3	-2.2
y2017 - y2016	9.1	0.3	12.9	42.6	14.4	33.8	6.2
y2018 - y2017	13.4	1	-1.9	31.3	12.1	61.5	14.6
y2019 - y2018	13	7.5	4.5	80.3	16.6	97.8	1.6
y2020 - y2019	4.8	1.1	21.2	57.1	33	170	8
y2021 - y2020	5.3	5.5	28.9	25.3	-31.1	443.6	-3.6
y2022 - y2021	9.2	7.7	49.5	21.5	14.2	83.3	0.8
y2023 - y2022	12.7	2.9	13.2	152.8	-1.7	236.7	9.7

Table 5b The evolution of number of scientists and engineers
(thousand persons; from 15 to 74 years; DK – HR)

The minimum and maximum values of the indicator for the next group of countries are (Table 5c): Hungary: -10.2 thousand people in 2023 compared to 2022 and 54.9 thousand people in 2020 compared to 2019; Ireland: 5.2 thousand people in 2015 compared to 2014 and 26 thousand people in 2021 compared to 2020; Italia: -9.2 thousand people in 2021 compared to 2020 and 87.3 thousand people in 2023 compared to 2022; Lithuania: -0.2 thousand people in 2020

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

compared to 2019 and 14.9 thousand people in 2021 compared to 2020; Luxembourg: -2.6 thousand people in 2015 compared to 2014 and 6 thousand people in 2021 compared to 2020; Latvia: -0.4 thousand people in 2018 compared to 2017 and 9.7 thousand people in 2022 compared to 2021; Malta: 0.2 thousand people in 2020 compared to 2019 and 4.1 thousand people in 2019 compared to 2018.

Absolute chain increment	HU	IE	IT	LT	LU	LV	MT
y2015 - y2014	11.8	5.2	20.8	3	-2.6	-0.4	0.7
y2016 - y2015	0.1	8.4	20.9	1.6	1.1	1.5	2
y2017 - y2016	9.2	17.9	5.1	1.9	1.7	1.8	1.9
y2018 - y2017	16.1	7.3	41.6	4.5	1.7	-0.4	2.2
y2019 - y2018	24.7	9	42.4	5.7	3.9	2.1	4.1
y2020 - y2019	54.9	12.6	-8.2	-0.2	0.9	6.7	0.2
y2021 - y2020	9.7	26	-9.2	14.9	6	0.2	2.2
y2022 - y2021	-3.5	23.3	1.3	10.8	0.4	9.7	0.5
y2023 - y2022	-10.2	25.5	87.3	12.1	1.5	3.5	1.8

Table 5c The evolution of number of scientists and engineers (thousand persons; from 15 to 74 years; HU – MT)

For the last group of countries (Table 5d) we have the next minimum and maximum values of the indicator: Netherlands: 5.8 thousand people in 2023 compared to 2022 and 142.7 thousand people in 2021 compared to 2020; Poland: 4.8 thousand people in 2016 compared to 2015 and 153.9 thousand people in 2023 compared to 2022; Portugal: -27.2 thousand people in 2021 compared to 2020 and 43.2 thousand people in 2020 compared to 2019; Romania: -54.4 thousand people in 2023 compared to 2022 and 45 thousand people in 2022 compared to 2021; Sweden: -4.2 thousand people in 2023 compared to 2022 and 54.2 thousand people in 2022 compared to 2021; Slovenia: -18 thousand people in 2023 compared to 2022 and 20.8 thousand people in 2021 compared to 2020; Slovakia: -3.5 thousand people in 2015 compared to 2014 and 13.1 thousand people in 2020 compared to 2019.

Absolute chain increment	NL	PL	PT	RO	SE	SI	SK
y2015 - y2014	27.5	10.2	21.3	14.3	23.2	9.3	-3.5
y2016 - y2015	17.5	4.8	6.1	15.1	36.7	-1.2	-1.5
y2017 - y2016	21.5	56.2	22.3	13.1	19.5	1	11.9
y2018 - y2017	61.8	51	37.4	13.4	30.9	5	9.4
y2019 - y2018	66.8	113.5	35	5.9	40.9	2.1	10.1
y2020 - y2019	31.3	10.5	43.2	0	19.8	9.8	13.1
y2021 - y2020	142.7	70.8	-27.2	31.7	44.8	20.8	4.2
y2022 - y2021	91.8	28.5	37.2	45	54.2	0.6	10.4
y2023 - y2022	5.8	153.9	33.4	-54.4	-4.2	-18	12.1

Table 5d The evolution of number of scientists and engineers (thousand persons; from 15 to 74 years; NL – SK)

3. Conclusions

Concerning the evolution of number of *persons with tertiary education (ISCED) and/or employed in science and technology* we can draw the following conclusions: Overall EU-27 Trends: steady growth from 2014 to 2019 (2000-2500K annual increase), sharp decline in 2020 (780.9K) due to pandemic, strong recovery post-2020, reaching highest growth in 2023 (2859.4K).

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

Major Country Contributors: Germany (DE): largest volatility (-233.3K to +686.6K); France (FR): most consistent growth (175.3K to 461.5K); Poland (PL): dramatic recent growth (547.5K in 2023); Spain (ES): steady upward trend (240.1K to 409.2K).

Regional Patterns: Western Europe: generally stable growth (FR, DE), Eastern Europe: more volatile (PL, RO), Southern Europe: mixed performance (ES positive, IT variable), Northern Europe: moderate, steady growth (SE, DK).

Impact Periods: Pre-pandemic (2014-2019): stable growth across most countries; Pandemic (2019-2020): universal slowdown or decline; Recovery (2020-2023): varied recovery patterns: strong: PL, FR, ES; moderate: DE, NL; weak: some smaller countries.

Country Size Impact: larger countries (DE, FR, ES, PL) show larger absolute changes, smaller countries (MT, LU, CY) show more modest but often stable growth, medium-sized countries show varied patterns.

Key findings from the *tertiary education* data: Overall EU-27 Trends: generally positive growth throughout the period; notable dip in 2019-2020 (1437.4K vs. 2434.7K previous year); strong recovery in 2020-2021 (2604.4K); relatively stable in recent years around 2200-2500K annual increase.

Country-Specific Patterns: Major Contributors: Poland (PL): dramatic increase in 2022-2023 (650.6K), previously showing declining trend, high volatility in numbers; Germany (DE): consistent contributor, strong performance in 2022-2023 (574.5K), relatively stable pattern with periodic peaks; France (FR): steady growth, peak in 2020-2021 (552.9K), generally stable contributor; Italy (IT): highly variable pattern, near-zero growth in 2019-2020, strong recovery in 2022-2023 (396.9K).

Regional Patterns: Northern Europe: Sweden: moderate but stable growth; Denmark: consistent small positive increments; Eastern Europe: notable volatility (Poland, Romania), Romania showing recent decline (-127.3K in 2023); Southern Europe: Spain: strong consistent growth; Italy: volatile but generally positive; Western Europe: France and Germany: most stable large contributors; Netherlands: consistent growth until recent slowdown.

Pandemic Impact and Recovery: clear impact in 2019-2020 across most countries; variable recovery patterns: some immediate (France), some delayed (Italy), some still struggling (Romania).

Recent Trends (2022-2023): strong positive: Poland (650.6K), Germany (574.5K), Italy (396.9K); negative trends: Romania (-127.3K), Slovenia (-59.1K), Slovakia (-5.2K); mixed performance in smaller countries.

Based on the data and visualization on *persons employed in science and technology*, here are some key observations: Overall EU-27 Trend: shows generally positive growth with significant year-to-year variations; largest increase was in 2023 (+2,344,000 persons); Notable dip in 2020 (likely due to COVID-19 pandemic) with only +247,700 increase.

Major Country Patterns: Germany (DE) showed high volatility, with a major decrease in 2020 (-769,300); France (FR) has shown consistent growth, particularly strong in recent years; Italy (IT) experienced significant fluctuations, including negative growth in 2020-2021; Poland (PL) shows variable but generally positive growth.

Notable Events: 2020 impact: many countries showed reduced or negative growth; strong recovery: most countries showed significant rebounds in 2021-2023; Recent trends: 2023 showed particularly strong growth in several countries.

Conclusions after analyzing the number of *persons with tertiary education (ISCED) and employed in science and technology*: Education Level Trends: a large proportion of new science and technology jobs are filled by those with tertiary education; the gap between total and tertiary-educated employment growth varies by country and year; in

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN EU COUNTRIES – AN OVERVIEW

some cases, tertiary-educated growth exceeds total growth, suggesting possible job requirement upgrades.

Country-Specific Patterns: Germany (DE): shows similar patterns in both datasets but with smaller amplitude in tertiary education; France (FR): often shows higher growth in tertiary-educated positions than total positions; Poland (PL): shows strong growth in tertiary education, particularly in 2023 (+402,300).

Crisis and Recovery: 2020 (COVID-19 impact): tertiary-educated positions were more resilient, showing positive growth (+904,100) while total employment growth was much lower (+247,700); 2021 recovery: both categories showed strong growth, with tertiary education growing even more than total employment.

Recent Trends (2022-2023): most countries show continued growth in both categories; the proportion of tertiary-educated workers continues to increase; some countries (e.g., Slovenia, Latvia) show recent decreases in both categories.

Key findings from analyzing *scientists and engineers* data in comparison with previous datasets: Overall Trends: scientists and engineers show more stable growth compared to total S&T employment; the number of scientists and engineers was less affected by the 2020 crisis, showing continuous positive growth (+614,300); the proportion of scientists and engineers within total S&T employment has been increasing.

Country-Specific Patterns: France shows strong recent growth in scientists/engineers (+236,700 in 2023); Germany maintains steady growth but with more moderate numbers; Poland shows significant increase in 2023 (+153,900); some smaller countries show decline or stagnation (Hungary, Slovenia).

Notable Changes: 2021 saw the largest increase (+1,175,300 EU-wide); most recent data (2023) shows strong growth (+882,100); several countries show contrasting patterns between total S&T employment and scientists/engineers.

Regional Variations: Western European countries generally show more stable growth; Eastern European countries show more volatile patterns; Southern European countries (especially Spain and Italy) show recent strong growth.

References:

- [1]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_ncat/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [2]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_nocc/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [3]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_nsec2/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [4]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_nsecsex2/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [5]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_nunsex/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [6]https://ec.europa.eu/eurostat/databrowser/view/hrst_st_nunsex2/default/table?lang=en&category=scitech.hrst.hrst_st.hrst_st_nat last retrieved 1st November 2024
- [7]https://ec.europa.eu/eurostat/cache/metadata/en/hrst_esms.htm last retrieved 1st November 2024