R & D personnel

Statistics Explained

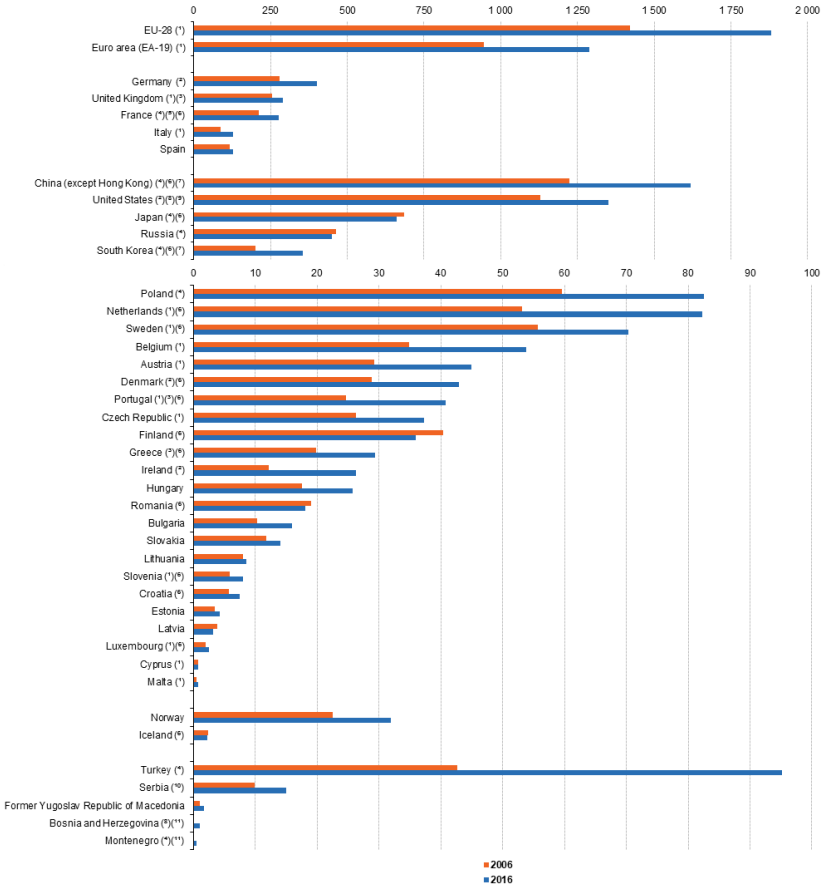
Data extracted in March 2018. Planned article update: March 2019.

This article analyses data on research and development (R & D) personnel, researchers , human resources in science and technology (HRST) and doctorate/PhD students in the European Union (EU) . Statistics on science and technology personnel are key indicators for measuring the knowledge-based economy and its developments, for example, providing information on the supply of, and demand for, highly qualified science and technology specialists.

Researchers

The number of researchers in the EU-28 increased in recent years: there were 1.88 million researchers (in full-time equivalents (FTE)) employed in the EU-28 in 2016 (see Figure 1), which marked an increase of 459 thousand (or almost one third, 32.2 %) when compared with 2006. The number of researchers more than doubled between 2006 and 2016 in Ireland, while relatively high growth rates were also recorded for Portugal (65.3 %), Malta (59.1 %), Bulgaria, the Netherlands (both 54.8 %), Belgium (54.2 %) and Austria (53.9 %). By contrast, the number of researchers fell in Latvia (-19.9 %), Finland (-11.1 %) and Romania (-5.1 %).

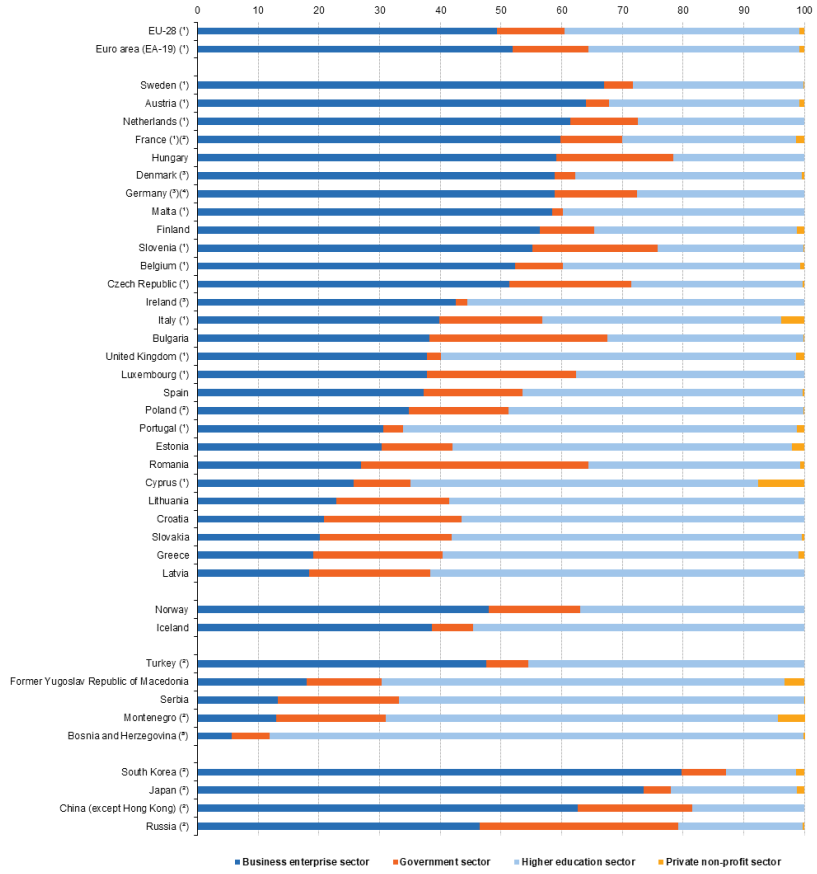
Among the non-member countries shown in Figure 1, the number of researchers in China (excluding Hong Kong) reached 1.62 million in 2015, which was higher than in the United States (1.35 million; 2016 data); both of these values were below the total number of researchers in the EU-28 in 2016. During the period 2006-2015, the number of researchers in Turkey more than doubled, while there was also a rapid increase in the number of researchers in South Korea (up overall by more than three quarters, 78.2 %). China recorded a similar growth rate to the EU-28, with its number of researchers rising by 32.3 %, whereas the number of researchers in Japan fell by a modest amount (-3.3%). There were two other non-member countries among those for which data are shown in Figure 1 which reported a reduction in their number of researchers between 2006 and 2015, namely, Russia and Iceland (2006-2016).



Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm. The figure is split into two parts with different y-axes.
(*) 2016: provisional.
(*) 2016: estimate.
(*) 2006: estimate.
(*) 2015 instead of 2016.
(*) 2015: provisional.
(*) Break in series.
(*) 2006: definition differs.
(*) 2014 instead of 2016.
(*) 2014: estimate.
(*5) 2008 instead of 2006.
(**) 2006: not available.
Source: Eurostat (online data code: rd_p_persocc)

Figure 1: Number of researchers, 2006 and 2016
(thousand full-time equivalents)
Source: Eurostat (rdppersocc)

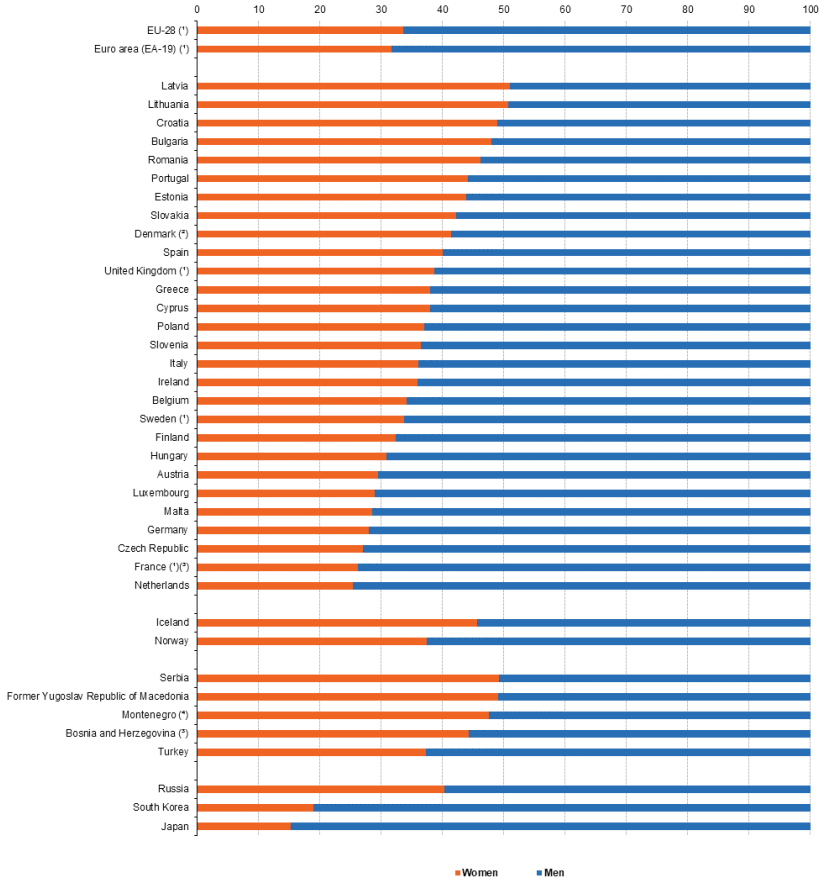
An analysis of R & D personnel by sector in 2016 shows that in the EU-28 there was a high concentration of researchers in the business enterprise sector (49.3 %) and the higher education sector (38.6 %), while 11.2 % of the total number of researchers were working in the government sector . The relative importance of the different sectors varied considerably across the EU Member States, with business enterprises accounting for three fifths or more of all researchers in Sweden, Austria and the Netherlands. By contrast, the government sector employed the highest share of researchers in Romania (37.4 %). A majority of researchers working in Portugal (64.9 %), Latvia (61.7 %), Greece and Lithuania (both 58.6 %), the United Kingdom (58.4 %), Slovakia (57.6 %), Cyprus (57.3 %), Croatia (56.5 %), Estonia (55.9 %) and Ireland (55.5 %) were employed within the higher education sector, and this sector also accounted for the highest share (although less than 50 %) of all researchers in Spain and Poland (2015 data). In terms of its number of researchers, the private non-profit sector was the smallest in all EU Member States; its highest share (7.6 % of all researchers) was recorded in Cyprus, while the next highest share was in Italy (3.8 %).



Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm.
(*) Provisional.
(*) 2015.
(*) Estimates.
(*) Definition differs.
(*) 2014.
Source: Eurostat (online data code: rd_p_persocc)

Figure 2: Researchers, by sector, 2016
(% share of total number of researchers, based on full-time equivalents)
Source: Eurostat (rdppersocc)

An analysis by sex shows that men accounted for approximately two thirds (66.4 %) of the EU-28's workforce of researchers in 2015. Women accounted for just over half of the total number of researchers in 2015 in both Lithuania (50.7 %) and Latvia (where their share peaked at 51.0 %), while the share of women in the total number of researchers was also close to parity in Croatia, Bulgaria and Romania (see Figure 3). The gender gap in terms of the count of researchers in each of the EU Member States was largest in the Netherlands, France (2014 data) and the Czech Republic, where close to three quarters of all researchers were men.

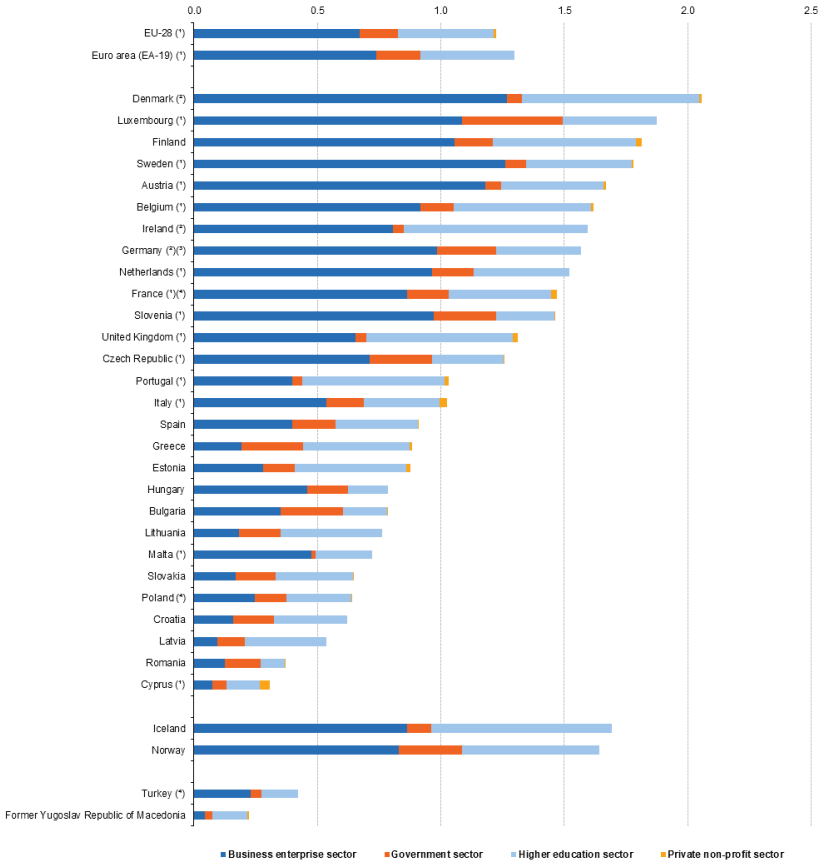


Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm.
(*) Estimates.
(*) Provisional.
(*) 2014.
(*) Definition differs.
Source: Eurostat (online data code: rd_p_persocc)

Figure 3: Gender analysis of researchers, 2015
(% share of total number of researchers, based on head count)
Source: Eurostat (rdppersocc)

R & D personnel

R & D personnel from all sectors together accounted for a share of more than 2.0 % of the total labour force in Denmark in 2015, compared with an EU-28 average of 1.2 %; note these figures are based on information in full-time equivalents. Aside from Denmark, the share of R & D personnel in the total labour force ranged from 0.3 % in Cyprus and 0.4 % in Romania up to 1.7 % in Austria, 1.8 % in Sweden and Finland, and 1.9 % in Luxembourg (see Figure 4).



Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm.
(*) Provisional.
(*) Estimates.
(*) Definition differs.
(*) 2014
Source: Eurostat (online data code: rd_p_perslf)

Figure 4: R & D personnel, by sector, 2015
(% share of total labour force, based on full-time equivalents)
Source: Eurostat (rdpperslf)

Human resources in science and technology

Human resources in science and technology (HRST) provide information concerning the demand for and the supply of people with high qualifications in science and technology. More than 78 million people in the EU-28 were employed in science and technology (S and T) occupations in 2016; this made up almost one third (32.1 %) of the total labour force aged 15-74 (see Figure 5). Persons in S and T occupations accounted for over half (50.9 %) of the total labour force in Luxembourg in 2016 and for around two fifths of the total in Sweden (42.8 %), Denmark (39.7 %), Finland (39.1 %), the Netherlands (39.0 %) and Germany (38.2 %), as well as in Norway (42.0 %), Switzerland (41.6 %) and Iceland (39.0 %). By contrast, the lowest share of people working in a science and technology occupation was recorded in Romania (20.0 %), while shares of less than one quarter were also recorded in Greece, Spain, Slovakia and Bulgaria.

Although the letters S and T in the official definition of HRST in the Canberra manual refer to science and technology, the definition is not limited to science and technology in the strict sense. HRST by education covers all fields of study, in other words anybody who successfully completed a tertiary level education . The HRST 'core' (HRSTC) — which is made up of people who possess a tertiary level education and are employed in science and technology occupations — amounted to 50 million persons in 2016 across the whole of the EU-28, or just over one fifth (20.7 %) of the total labour force. Concerning the HRST 'core', the range between countries was similar to that observed for HRST occupations. Slovakia, Romania and Italy were the only EU Member

States to report that less than 15.0 % of their labour force were HRST 'core' in 2016, while at the other end of the scale this share rose to 28.5 % in Sweden, 29.0 % in Finland and 34.3 % in Luxembourg (see Figure 5).

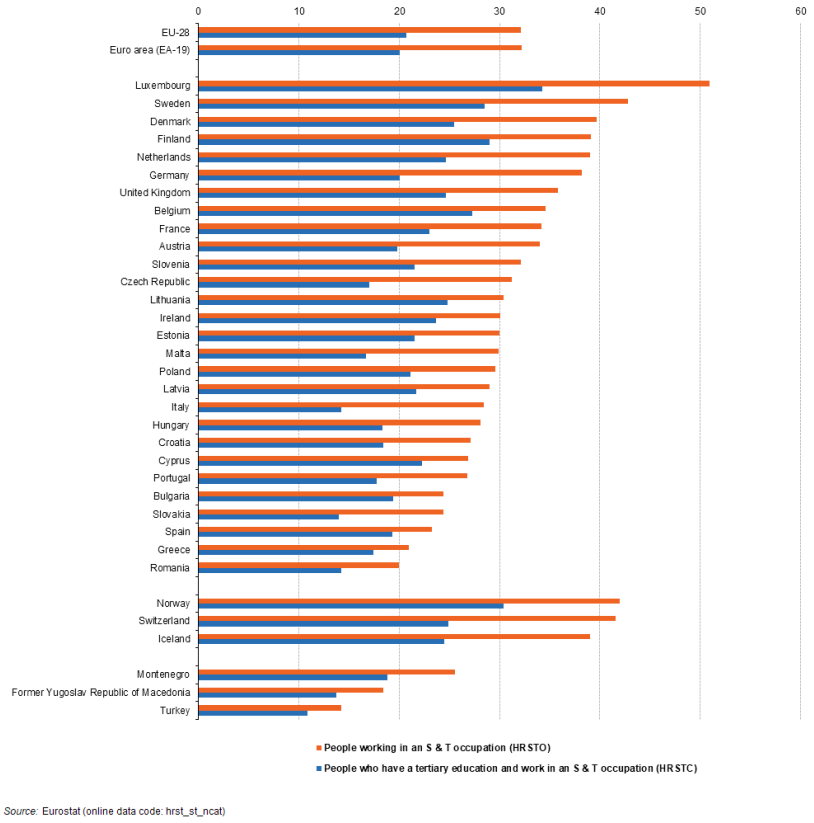


Figure 5: Human resources in science and technology, 2016
(% share of total labour force aged 15-74)
Source: Eurostat (hrststncat)

Between 2011 and 2016 there was a considerable increase in the relative importance of people classified as HRST 'core' within the EU-28's labour force, as their share rose by 2.2 percentage points (see Figure 6). In fact, this share increased in all EU Member States except for Germany (where it fell by 0.6 points). The largest increases in the relative importance of the HRST core workforce were recorded in Austria (up 7.3 points), Latvia (up 5.0 points), Portugal (up 4.7 points), Sweden (up 4.6 points) and Croatia (up 4.2 points).

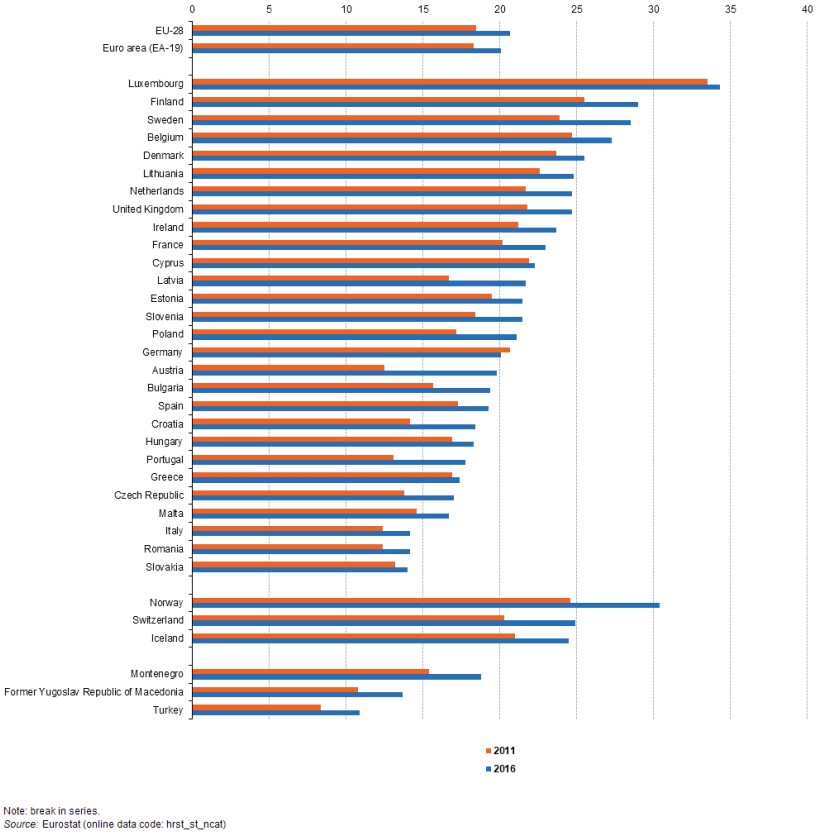
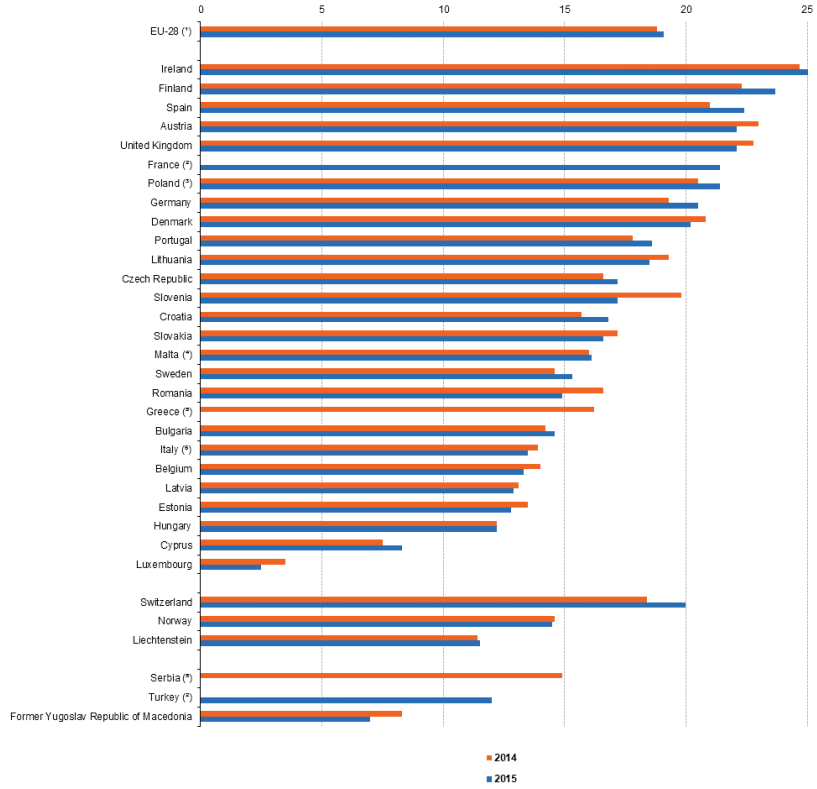


Figure 6: People who have a tertiary education and work in a science and technology occupation, 2011 and 2016
(% share of total labour force aged 15-74)
Source: Eurostat (hrststncat)

Science and technology graduates

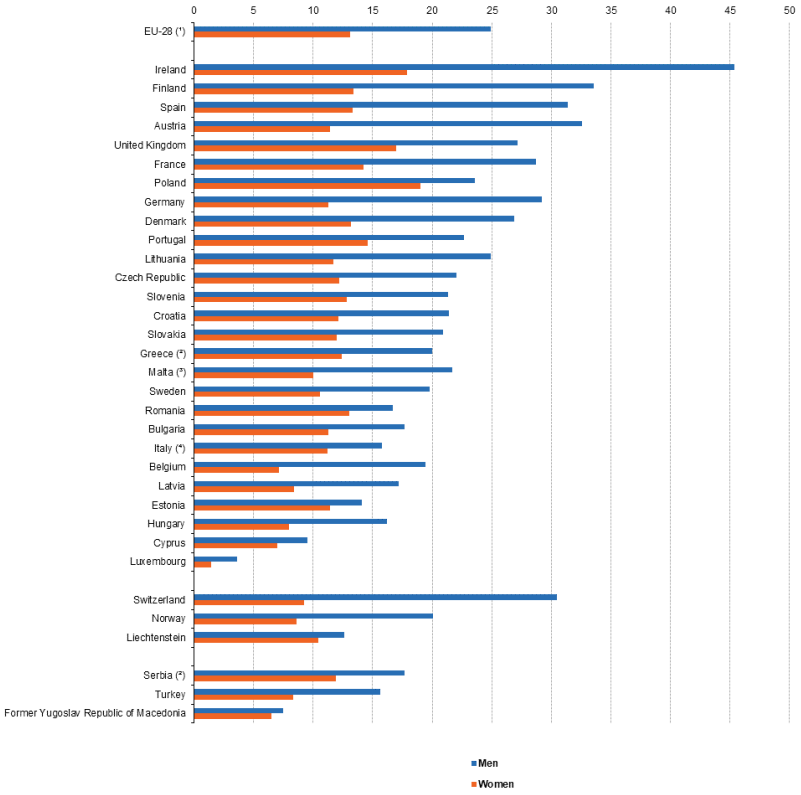
Moving away from the broad definitions of HRST, Figures 7 and 8 look at science and technology fields of education: these include natural science, mathematics and statistics; information and communication technologies; engineering, manufacturing and construction. Within the EU-28, in 2015 there were 19.1 graduates from science and technology fields of education per 1 000 persons aged 20 to 29 years. Among the EU Member States, relatively high ratios — above 20.0 graduates per 1 000 persons aged 20 to 29 years — were recorded in Denmark, Germany, Poland, France, the United Kingdom, Austria, Spain, Finland and Ireland (where this ratio peaked at 31.5 graduates per 1 000 persons aged 20 to 29 years). Note this ratio should be interpreted with care as some graduates reported by a country may be foreigners who return home following their studies and so push up the ratio in the country where they studied and pull down the ratio for their country of origin; this may explain to a large extent the very low ratio recorded in one of the smallest EU Member States, namely Luxembourg (2.5 graduates from science and technology fields of education per 1 000 persons aged 20 to 29) and also the relatively low ratio recorded for Cyprus (8.3). Among the non-member countries shown in Figure 8, Switzerland stood out as it was the only one of these countries to record more science and technology graduates per 1 000 population aged 20-29 than the EU-28 average (at 20.0 per 1 000).



Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm. The Netherlands: not available.
(*) 2015: estimate.
(*) 2014: not available.
(*) 2014: definition differs.
(*) 2015: provisional.
(*) 2015: not available.
(*) 2015: definition differs.
Source: Eurostat (online data code: educ_uoe_grad04)

Figure 7: Science and technology graduates, 2014 and 2015
(tertiary graduates in science and technology per 1 000 persons aged 20-29 years)
Source: Eurostat (educuoegrad04)

An analysis of science and technology graduates by sex shows that men (aged 20-29) were more likely to graduate in these fields than women: in 2015, the EU-28 registered 24.9 male tertiary graduates in science and technology per 1 000 men aged 20-29 and 13.1 female tertiary graduates per 1 000 women of the same age, a difference of 11.8 per 1 000. A gender gap was observed in all EU Member States in 2015, ranging from 2.2 per 1 000 in Luxembourg to 21.2 per 1 000 in Austria and 27.5 per 1 000 in Ireland.



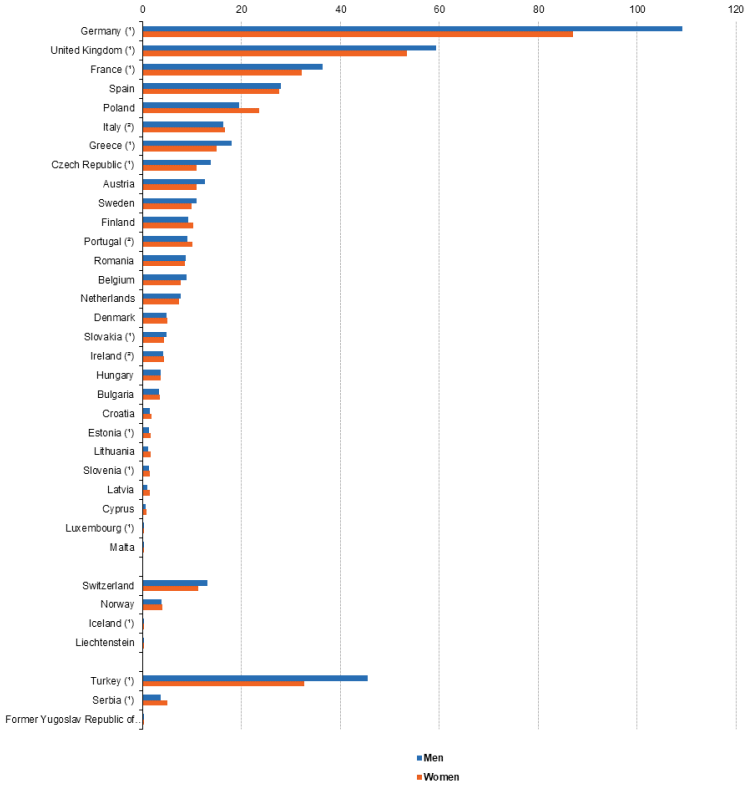
Note: ranked on the ratio for all graduates (men and women combined). When definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm. The Netherlands: not available.
(1) Estimates.
(2) 2014.
(3) Provisional.
(4) Definition differs.
Source: Eurostat (online data code: educ_uoe_grad04)

Figure 8: Science and technology graduates, 2015
(tertiary graduates in science and technology per 1 000 persons aged 20-29 years)
Source: Eurostat (educuoegrad04)

Doctoral students

A similar but more specific measure of a country's potential research capability is provided by the number of doctoral (PhD) students (see Figure 9). In 2015, there were an estimated 726 thousand doctoral students in the EU-28. Women accounted for slightly less than half (an estimated 47.8 %) of doctoral students in the EU-28 in 2015.

The gender split of doctoral students across the EU Member States was typically quite balanced: women accounted for more than half of all the doctoral students in 14 of the 28 Member States in 2015 or 2016, their share peaking at 59.7 % in Latvia (2016 data). Among the 14 Member States where there were a higher number of male (than female) PhD students, the share of men never rose higher than 56 %. Among the non-member countries that are shown in Figure 9, Iceland, Serbia, the former Yugoslav Republic of Macedonia and Norway (2016 data) each reported that more than half of all their doctoral students were women in 2015, although this share fell to 28.9 % in Liechtenstein (2016 data).

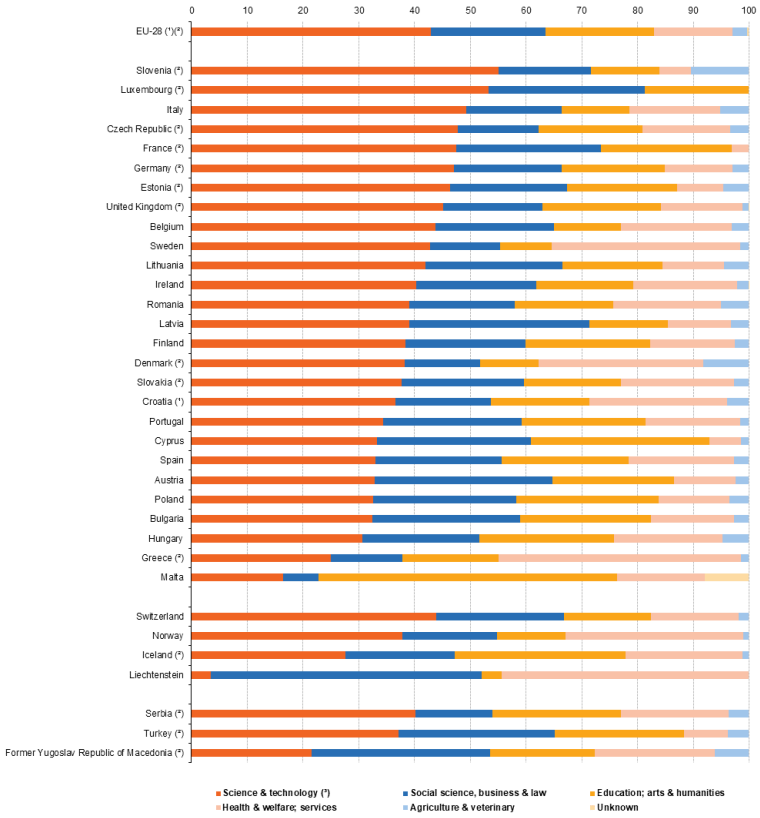


Note: ranked on the total number of PhD students (men and women combined). When definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm.
(*) 2015.
(*) Definition differs.
Source: Eurostat (online data code: educ_uoe_enrt01)

Figure 9: Number of PhD students, 2016
(thousands)
Source: Eurostat (educuoeenrt01)

In relative terms, the broad group covering science and technology accounted for 42.9 % of the doctoral students in the EU-28 in 2015, a proportion that was higher than in any all but one of the non-member countries shown in Figure 10; the only exception was Switzerland (43.9 %, 2016 data).

Among the EU Member States, science and technology fields of education accounted for more than half of all doctoral students in Slovenia and Luxembourg, while the lowest shares were recorded in Greece (24.9 %; 2015 data) and Malta (16.4 %). The next most common fields of education for doctoral studies in the EU-28 included social science, business and law (20.6%) and education, arts and humanities (19.5 %).



Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm. The Netherlands: not available.
(*) Definition differs.
(*) 2015.
(*) Natural science, mathematics and statistics; information and communication technologies; engineering, manufacturing and construction.
Source: Eurostat (online data code: educ_uoe_enrt03)

Figure 10: PhD students, by field of education, 2016
(% share of total PhD students)
Source: Eurostat (educuoeenrt03)

Data sources

R & D personnel

Statistics on R & D personnel are compiled using guidelines laid out in the 6th edition of the Frascati manual , published in 2002 by the OECD ; the manual was updated with improved guidelines reflecting changes in the way that R & D is funded and carried out — see the Frascati manual 2015 .

R & D personnel include all persons employed directly within R & D, as well as persons supplying direct services (such as managers, administrative staff and clerical staff). For statistical purposes, indicators on R & D personnel are compiled as both head counts (HC) and as full-time equivalents (FTEs).

Researchers are a subcategory of R & D personnel and are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.

Human resources in science and technology (HRST)

Statistics on human resources in science and technology (HRST) are compiled using guidelines laid out in the Canberra manual, prepared in cooperation between the OECD, European Commission , UNESCO and the International Labour Organisation (ILO) and published in 1995. HRST data can be analysed by sex, age, region,

sector of activity, occupation, educational attainment and fields of education (although not all combinations are possible). Data relating to stocks of HRST provide information on the number of HRST at a particular point in time; these stock data relate to the employment status as well as the occupational and educational profiles of individuals.

HRST based on education (HRSTE) are persons having successfully completed tertiary education, defined as levels 5, 6, 7 or 8 of the 2011 version of the international standard classification of education (ISCED) . Previously it was defined as levels 5 (a or b) or 6 of the 1997 version of ISCED.

HRST based on occupation (HRSTO) are persons who are employed in science and technology occupations as 'professionals' or 'technicians and associate professionals' within the international standard classification of occupations (ISCO-08) .

Persons who fulfil both education and occupation criteria are classified as the HRST 'core' (HRSTC).

Information on HRST flows from education are obtained from a UNESCO/OECD/Eurostat questionnaire on education and can be used to provide a measure of the current and future supply of HRST from the education system, in terms of actual inflows (graduates from the reference period) and potential inflows (students participating in higher education during the reference period).

Science, technology and innovation

Statistics on science, technology and innovation are based on Decision No 1608/2003/EC of the European Parliament and the Council concerning the production and development of Community statistics on science and technology. The Decision was implemented through European Commission Regulation (EC) No 753/2004 on statistics on science and technology, adopted in 2004. In 2012, a new European Commission Regulation (EU) No 995/2012 concerning the production and development of Community statistics on science and technology was adopted.

Science and technology graduates are defined as the number of new graduates from all public and private institutions completing science and technology-related graduate and postgraduate studies in the reference year. To facilitate comparisons, the number of graduates may be expressed relative to the total number of persons aged 20-29 years and 25-29 years.

Doctoral students

Indicators based on the number of doctoral (PhD) students give an idea of the extent to which countries will have researchers at the highest level of education in the future. The data relate to the number of students in the reference year; they do not refer to the number of new graduates or to the total number (stock) of graduates in the labour market that year. The number of doctoral students is measured as students enrolled in ISCED 2011 level 8: this level concerns tertiary programmes which lead to the award of an advanced research qualification. Programmes at this ISCED level are devoted to advanced study and original research and are typically offered only by research-oriented tertiary educational institutions such as universities. Doctoral programmes exist in both academic and professional fields.

Source data for tables and graphs

- R & D personnel: tables and figures

Context

The European Research Area (ERA) is composed of all research and development activities, programmes and policies in Europe which involve a transnational perspective. In May 2008, the European Commission adopted a Communication to launch an initiative titled, *Better careers and more mobility: a European partnership for researchers* (COM(2008) 317 final). The goal of this initiative is to improve the mobility of researchers and to enhance the diffusion of knowledge throughout Europe, by: balancing demand and supply for researchers at a

European level; helping create centres of excellence; and improving the skills of researchers in Europe.

With this in mind, the EU and its Member States set-up a pan-European initiative — EURAXESS: researchers in motion — which is designed to deliver information and support researcher mobility and career development, while enhancing scientific collaboration between Europe and the world. The same gateway is also used to promote the European Commission's initiative titled *Science4Refugees* , which is designed to help refugee researchers find jobs and to support refugee scientists in finding European researchers with whom they may discuss problems, find solutions and study together.

In December 2008, the Competitiveness Council adopted a definition for a 2020 vision for the ERA . According to the opening statement of this vision, all players should benefit from: the 'fifth freedom', introducing the free circulation of researchers, knowledge and technology across the ERA; attractive conditions for carrying out research and investing in R & D intensive sectors; Europe-wide scientific competition, together with the appropriate level of cooperation and coordination. This vision is part of the wider goals contained within the Europe 2020 strategy for smart, sustainable and inclusive growth.

In November 2011, the European Commission presented a successor for the 7th framework programme for research and technological development by announcing Horizon 2020 , a programme for investing nearly EUR 80 billion in research and innovation, implementing the innovation union. The Marie Sklodowska-Curie actions , under the 'excellent science' pillar of Horizon 2020, aim to support the career development and training of researchers — with a focus on innovation skills — in all scientific disciplines through worldwide and cross-sector mobility.

Other articles

- Human resources in science and technology - stocks
- R & D expenditure
- Science, technology and digital society statistics introduced

Publications

- Science, technology and innovation in Europe (Pocketbook — 2013 edition)
- Science, technology and innovation in Europe (Pocketbook — 2012 edition)
- Science, technology and innovation in Europe (Pocketbook — 2011 edition)
- Science, technology and innovation in Europe (Pocketbook — 2010 edition)
- Science, technology and innovation in Europe (Statistical book — 2010 edition)

Main tables

- Science and technology (tscitech) , see:

Research and development (tresearch)

Statistics on research and development (trd)

Total researchers by sectors of performance - head count (tsc00003)
Total researchers by sectors of performance - full time equivalent (tsc00004)
Research and development personnel, by sectors of performance (tsc00002)
Share of women researchers, all sectors (tsc00006)
Share of women researchers, by sectors of performance (tsc00005)

Human resources in Science & Technology (thrst)

Human resources in science and technology (HRST) (tsc00025)
Doctorate students in science and technology fields (tsc00028)

- Education and training (tedtr)

Education and training outcomes (teducoutc)

Science and technology graduates by sex (tps00188)

Database

- Science and technology (scitech) , see:

Research and development (research)
Statistics on research and development (rd)
R & D personnel at national and regional level (rdp)

Human Resources in Science &Technology (hrst)
Stocks of HRST at national and regional levels (hrstst)
Flows of HRST at national level (hrstfl)

- Education and training (edtr)

Participation in education and training (educpart)

Pupils and students - enrolments (educuoeenr)
Tertiary education (educuoeenrt)

Education and training outcomes (educoutc)

Graduates (educuoegrad)

Dedicated section

- Science, technology and innovation
- Education and training

Methodology

- Statistics on research and development (rd) (ESMS metadata file — rdesms)
- Human resources in science & technology (hrst) (ESMS metadata file — hrstesms)
- Education administrative data from 2013 onwards (ISCED 2011) (ESMS metadata file — educuoeenresms)

Legislation

- Decision No 1608/2003/EC of 22 July 2003 concerning the production and development of Community statistics on science and technology
- Regulation (EC) No 753/2004 of 22 April 2004 implementing Decision 1608/2003/EC
- Regulation (EU) No 995/2012 of 26 October 2012 implementing Decision 1608/2003/EC

External links

- European Commission — Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs European innovation scoreboards
- European Commission — Directorate-General for Research and Innovation — Science with and for society
- European Commission — EURAXESS — Researchers in motion
- European Commission — Horizon 2020
- European Commission — Joint Research Centre (JRC) — The EU Industrial R & D Investment Scoreboard

View this article online at http://ec.europa.eu/eurostat/statistics-explained/index.php/R_&_D_personnel