EU SKILLS PANORAMA 2014

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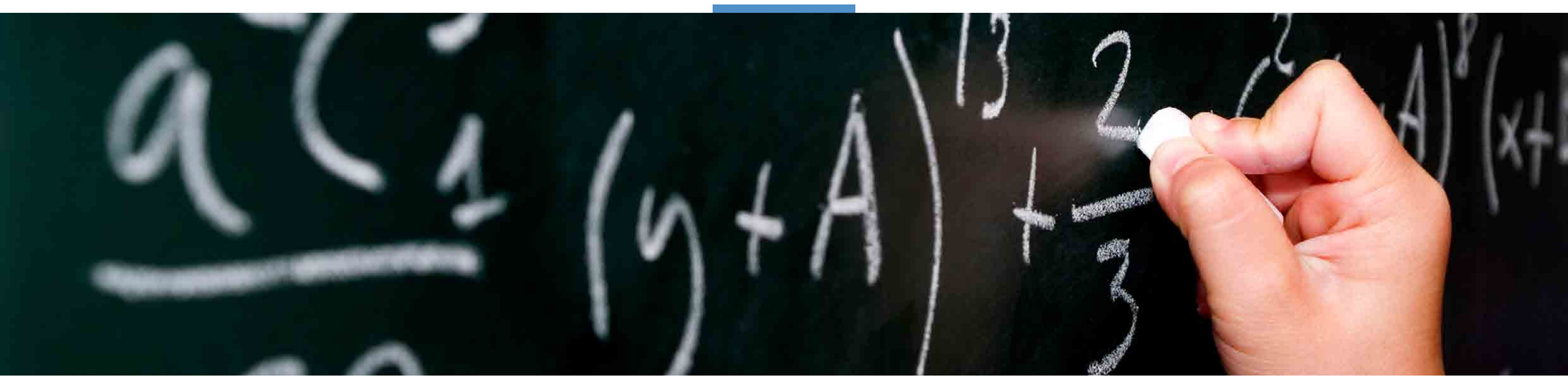
European Commission



## ANALYTICAL HIGHLIGHT

# FOCUS ON Science, technology, engineering and mathematics (STEM) skills

- STEM skills are critical to innovation and in creating a competitive edge in knowledge-intensive economies.
- From 2003 to 2013, the number of people working in STEM occupations grew by 12%, three times as much as total EU-28 employment. STEM occupations now account for 7% of all jobs.
- Much of this growth occurred from 2003 to 2008. However, there are signs of a recent upturn, which is creating recruitment difficulties in most EU-28 countries.
- Demand for STEM skills is anticipated to increase in the short and medium term. Whilst the numbers of STEM students and graduates are both increasing, some employers report that they are not 'job ready' and do not possess the 'right' skills, especially soft skills.

### What are STEM skills?

STEM skills are defined as those skills "expected to be held by people with a tertiary-education level degree in the subjects of science, technology, engineering and maths" (STEM)[1] [2]. These skills include "numeracy and the ability to generate, understand and analyse empirical data including critical analysis; an understanding of scientific and mathematical principles; the ability to apply a systematic and critical assessment of complex problems with an emphasis on solving them and applying the theoretical knowledge of the subject to practical problems; the ability to communicate scientific issues to stakeholders and others; ingenuity, logical reasoning and practical intelligence"[3] [4].

The understanding and scope of STEM skills varies widely from country to country[5]. Supply is relatively clearly identified in terms of qualifications achieved in STEM subjects, although definitions of STEM subjects can vary. For example, medicine, structural engineering and sports science are not included in some definitions. 'Core' STEM subjects typically include: Mathematics; Chemistry; Computer Science; Biology; Physics; Architecture; and, General, Civil, Electrical, Electronics, Communications, Mechanical, and Chemical Engineering[6] [7] [8],

The demand for and application of STEM skills is more difficult to define, given their application across a range of economic sectors and different occupations[9]. A study conducted in the USA[10] identified 30 STEM occupations i.e. those occupations which most utilise STEM skills[11]. These ranged from mathematicians, chemists, computer hardware engineers and civil engineers, to astronomers, agricultural and food science technicians and statisticians[12]. All 30 occupations fit into the occupational categories of: science and engineering professionals (ISCO/SOC 21[13]), information and communications technology professionals (ISCO/SOC 25), and science and engineering associate professionals (ISCO/SOC 31). These categories form the basis of the analysis below.

Anticipated growth in STEM occupations[14] and sectors[15], as well as reported recruitment difficulties, have focused attention on the current and future supply of STEM skills, and whether supply is sufficient now and in the future.

Figure 1 shows the number of tertiary education graduates with STEM qualifications – maths, science and technology[16]. In 2012, 23% of all EU-28 graduates held STEM qualifications, which is only a slight rise from 22% in 2007. By comparison, the respective figures for the USA and Japan were 16% and 22% in both years.

In 24 EU-28 countries, more than one in five graduates are STEM graduates, and in seven countries – Austria, Finland, Germany, Portugal, Romania, Slovenia and Sweden – more than one in four. Germany and Finland had the highest percentage of STEM graduates in 2012, whilst Belgium, the Netherlands and Poland had the fewest.

**Figure 1 – Graduates and enrolments (ISCED 5-6[17]) in mathematics, science and technology field – as % of all fields, EU-28, 2007-2012**

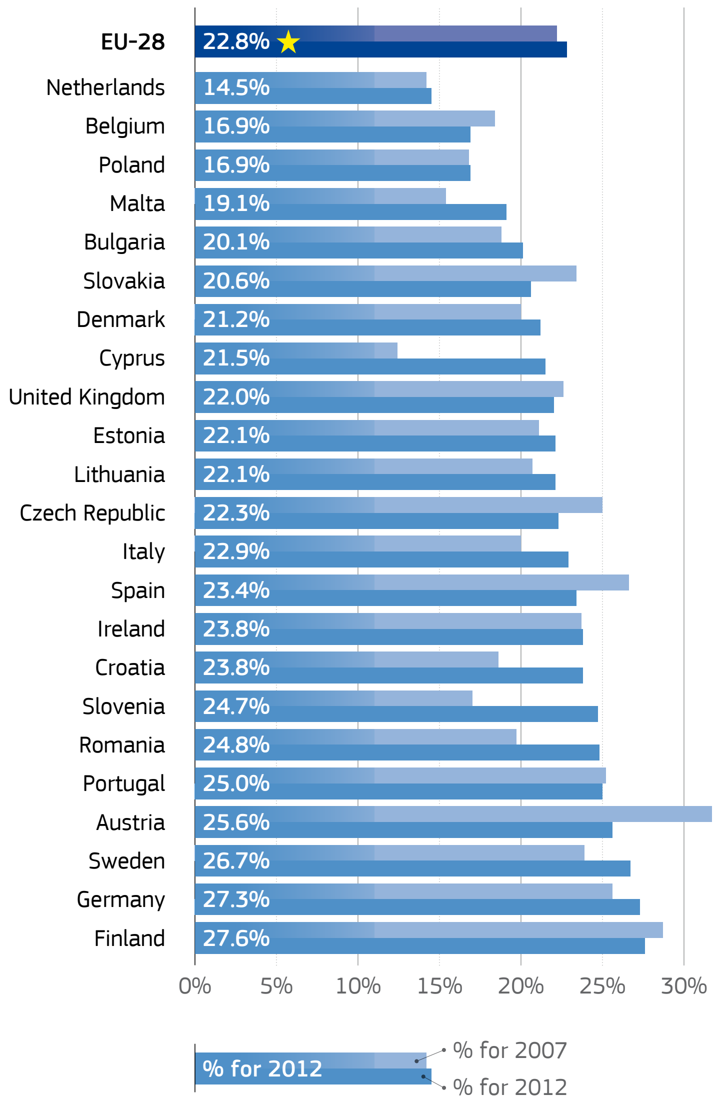
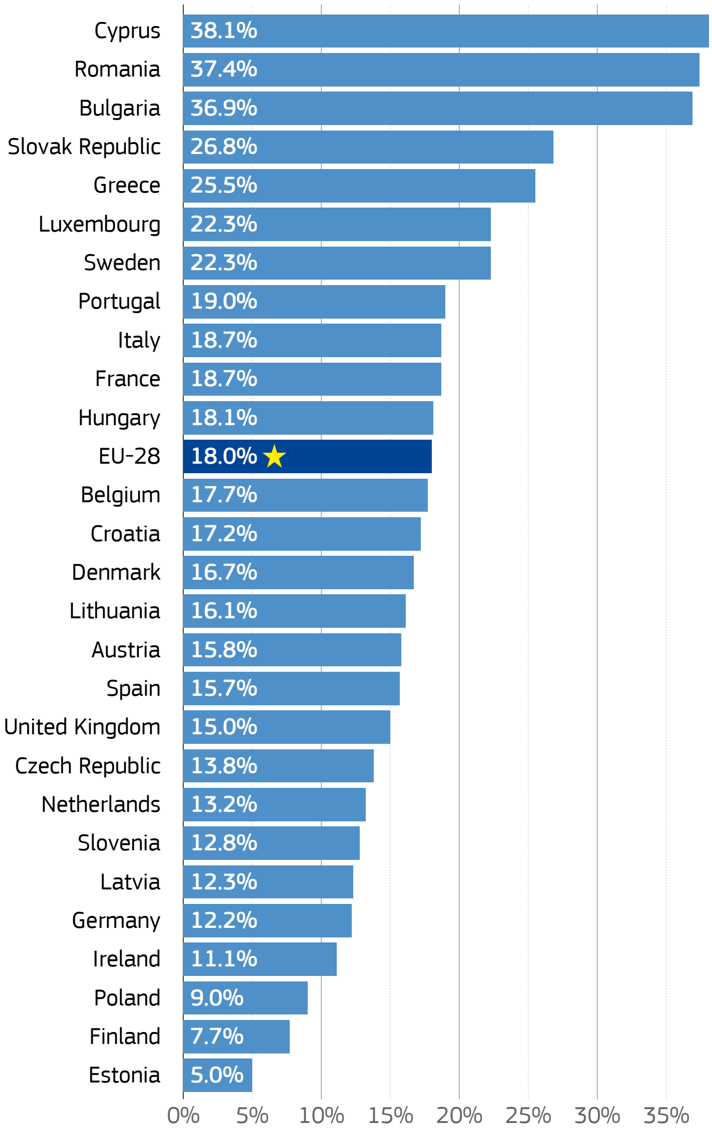



**Figure 2 – Low achievers (below Level 2) in science (as % of all surveyed pupils), EU-28, 2012**




Source: OECD (2014) Table I.5.1a[20].

There are clear gender differences in the number of STEM graduates. In nineteen EU-28 countries, there is at least a 25 percentage point difference in the proportion of female and male STEM graduates. Across the EU-28 as a whole, 14% of female students graduate with a STEM qualification, compared to 40% of male students. The gender difference tends to be bigger in those countries with the highest proportion of STEM graduates i.e. Finland, Germany and Sweden. In addition the Baltic States – Estonia, Latvia and Lithuania – have the largest gender gaps.

The supply of higher-level STEM skills is reliant on the development of competences, interest and passion in STEM subjects through the early years of education. Figure 2 shows that, according to the PISA survey, in 2012 nearly one in five pupils (18%) surveyed across the EU-28 had low level science skills (below Level 2) . This is similar to the OECD and USA average, but much higher than that of Korea (7%) and Japan (8%).

Across EU-28 countries, there is a considerable range in low-level science skills, from more than 35% of pupils surveyed in Cyprus, Romania and Bulgaria to less than 10% in Poland, Finland and Estonia[19].

In contrast to the STEM graduate figures, gender differences amongst pupils in both mathematics and science are small and reducing. Across EU countries, the percentage point difference between boy and girl pupils below Level 2 in mathematics remained small between 2009 and 2012. There was a decrease in this gender differential from 2.5 percentage points in 2009 to 1.8 percentage points in 2012. The share of low achievement in science is 1.7 percentage points higher amongst boys (17.4%) than it is amongst girls (15.7%), but the difference is small and has barely changed since 2009 (when it was 1.9 percentage points)[21].

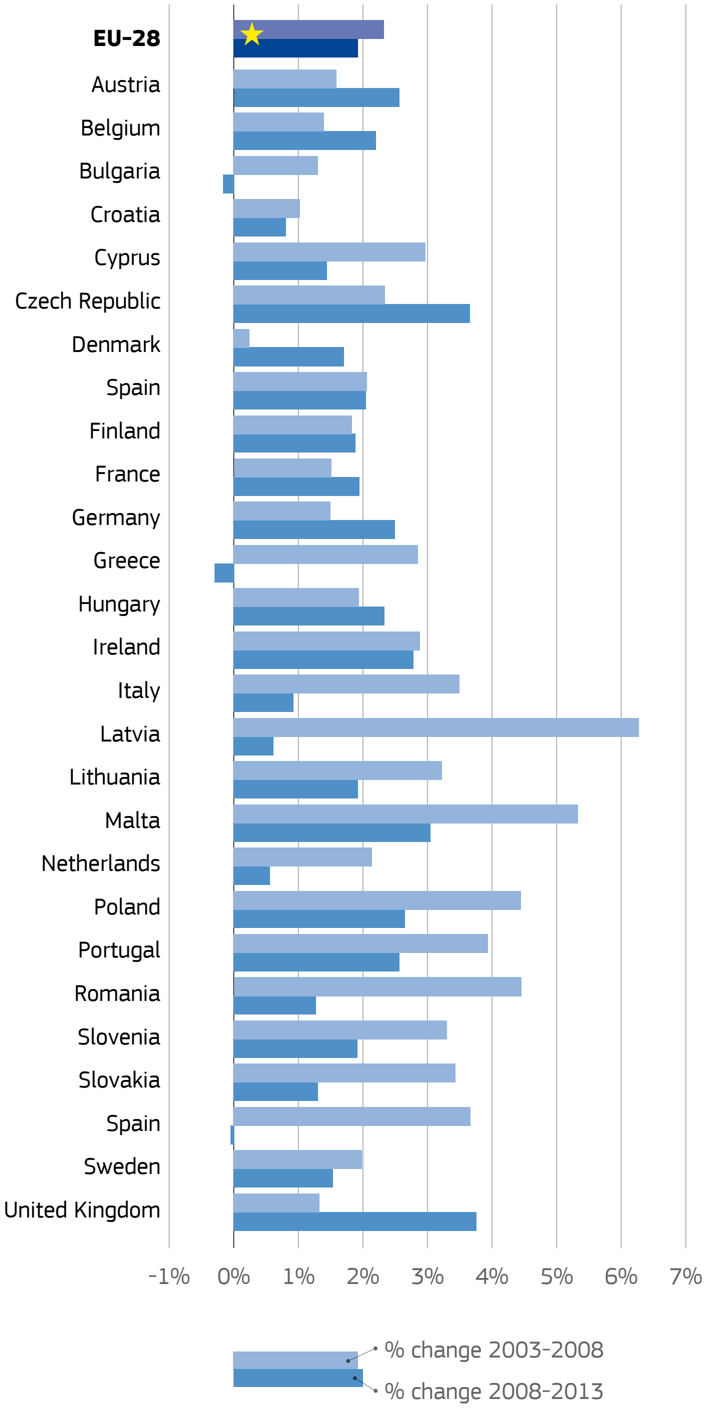
## Current demand for STEM skills

In 2013, employment of science and engineering professionals and associate professionals[22] constituted 7% of total EU-28 employment. From 2003 to 2013, the numbers grew by 1.8 million or 12%, at a time when total employment grew by only 4%[23 24 25]. However, virtually all of this growth in jobs occurred between 2003 and 2008.

From 2003 to 2008, the numbers employed in science and engineering professional occupations grew in every major sector and subsector. Growth was especially strong (24%) in real estate, professional, scientific and technical activities. From 2008 to 2013, employment increased again in most sectors, but at a lower rate. For example, in real estate, professional, scientific and technical activities employment grew by 7%.

For science and engineering associate professional occupations, the number of jobs grew by 9% from 2003 to 2008 and then declined by 2% in the period to 2013. The profile of employment by sector was similar: healthy growth in most sectors, including real estate, professional, scientific and technical activities, but then lower growth, particularly in construction (-7%).

Figure 3 – Change in the number of those working in science and technology with a tertiary (ISCED) education by country, EU-28, 2003-2008 and 2008-2013




Source: Eurostat, Labour Force Survey, table (hrst_st_ncat)[27]

Figure 3 shows the change in employment by country, of those working in science and technology with a tertiary (ISCED) education from 2003 to 2008, and from 2008 to 2013[26].

**Table 1 – Current and anticipated employment demand in key STEM-related occupations, EU-28, 2015-2025**

| | 2015 | 2025 (000s) | Change 2015-2025 |
|---|---|---|---|
| Science and engineering professionals | 4,420,000 | 5,086,000 | 13% |
| Science and engineering associate professionals | 10,666,000 | 11,434,000 | 7% |
| All occupations | 227,072,000 | 234,340,000 | 3% |

Source: Cedefop (2015)

Across the EU-28, there was strong growth in both time periods of at least 19%. From 2003 to 2008, there was only one country (Denmark) where percentage growth was less than 10%. From 2008 to 2013, despite the recession, all but three EU-28 countries (Belgium, Greece and Spain) had employment increases. Of those countries where the number of those working in science and technology with a tertiary (ISCED) education grew, only four had growth below 10%.

## Employment outlook

Employment for all occupations is expected to grow by 3% from 2015 to 2025. However, STEM professional and associate professional occupations are expected to grow by 13% and 7% respectively over this period.

## STEM skills issues

Recent studies identify a shortage of STEM professionals and the need to engage students at all levels in science to boost the supply of STEM workers[28].

Cedefop reports that most STEM-related occupations will require at least medium-level qualifications over the next 10 years or so[29]. Currently, around 48% of STEM-related occupations require medium (upper-secondary) level qualifications, many of which are acquired via upper-secondary level VET. However, whilst current levels of STEM higher education students and graduates are increasing[30], those achieving STEM qualifications through upper-secondary level VET is forecast to decline slightly to 46% in 2025[31].

This suggests that additional entry points into STEM occupations outside of the higher education system could be exploited to address recruitment difficulties and skills shortages. The evidence suggests that people can enter STEM occupations with non-tertiary/degree level qualifications if they have the requisite technical skills (as opposed to qualifications).

The need for more entry points (such as apprenticeships) is emphasised by employer survey results which show that some STEM graduates, whilst qualified, are considered under-skilled in terms of personal and behavioural competences. These 'employability skills' include: team-working, communication and time management/organisational skills, as well as the more commercially-related skills including product development, customer service and business acumen. The successful development of these skills requires an education system capable of preparing students through more active and problem-based learning approaches, using assignments from the 'real world' and including support for risk taking and creativity[32].

Recruitment difficulties which were supressed by the recession have begun to emerge again in a number of specific occupations for both science and engineering professionals, and associate professionals[33]. Recruitment difficulties for science and engineering professionals have been identified in 21 countries, mostly for mechanical engineers (in 9 countries), electrical engineers (9 countries), electronics engineers (7 countries), civil engineers (6 countries), industrial and production engineers (4 countries), and engineering professionals not elsewhere classified (3 countries). Recruitment difficulties for science and engineering associate professionals were reported in 14 countries. Half of these countries reported science and engineering associate professionals in their top ten occupations for recruitment difficulties. Most recruitment difficulties were found in: mechanical engineering technicians; physical and engineering science technicians; and draughtspersons.

A lack of technical skills and experience and the gender profile of these occupations were the main reasons provided for these recruitment problems[34]. This study's findings are reflected in a number of pan-European and national business surveys which have also identified current and potential skills shortages for STEM jobs[35 36 37].

## Addressing STEM skills issues

There are emerging skills shortages, skills gaps and recruitment difficulties. These problems are likely to get worse as the demand for STEM skills and occupations increases due to economic recovery and the pivotal role these skills and jobs play in economic development. A number of solutions have been developed to address the different facets of STEM skills problems. These include the need to combine the STEM skills of graduates with the 'soft' employability skills as communication skills, team working and creative thinking which help apply STEM skills in the business world and which are important to innovation[38].

Further, if the supply of STEM skills is not to be a constraint on the economic growth of Europe, greater advances are necessary in the early nurturing and attainment of STEM skills in schools, enhancing the wrap-around skills needed for the effective application of STEM skills in a multi-disciplinary, creative and collaborative work environment and informing graduates about the realities of a rewarding career in STEM related occupations.

Rather than focusing solely on the supply of STEM skills, other commentators have focused on the demand-side and the role of employers. At the forefront of such discussions are topics such as addressing the gender gap to broaden the pool of potential recruits, employer investment in STEM training (particularly below tertiary level) to generate and broaden pathways into STEM jobs[39], improving pay and conditions to reduce competition from other sectors[40 41 42], and competition from other countries[43]. ■

1 EU Skills Panorama Glossary at http://euskillspanorama.cedefop.europa.eu/Glossary/default.aspx?letter=S
2 Chaniel Fan and Ritz (2014), International views of STEM education
3 UK Parliament (2012), Science and Technology Committee – Second Report: Higher education in Science, Technology, Engineering and Mathematics (STEM) subjects
4 UKCES (2011) The supply and demand for high-level STEM skills, Briefing Paper, December 2011
5 Szu-Chun C.F., Ritz J.M. (2014), International views of STEM education
6 UKCES (2011) The supply and demand for high-level STEM skills, Briefing Paper, December 2011
7 UK Parliament (2012), Science and Technology Committee – Second Report: Higher education in Science, Technology, Engineering and Mathematics (STEM) subjects
8 Koonce, Jie Zhou and Anderson, American Society for Engineering Education (2012), What is STEM?
9 UK Commission for Employment and Skills (2013), The supply of and demand for high-level STEM skills, Evidence Report 77
10 ibid 9
11 Based on US sources such as O*Net, the Commission on Professionals in Science and Technology (CPST), and the National Employment Matrix.
12 ibid 9
13 ILO (2012), International Standard Classification of Occupations: Volume I
14 As defined above
15 STEM sectors are defined as those sectors which employ the highest proportions of people with STEM qualifications and working in STEM occupations.
16 These qualifications include: science, mathematics and computing; engineering, manufacturing and construction.
17 ISCED 5-6 equates to the first stage of tertiary education and higher i.e. at least degree-level education.
18 Data not available for either 2007 or 2012 in: Greece, France, Latvia, Luxembourg and Hungary
19 OECD (2014), PISA 2012 results: What students know and can do, student performance in mathematics, reading and science Volume 1
20 EU average refers to data from 27 Member States (excludes Malta for which data is not available). Low achieving is defined as below Level 2 and capable of carrying out only the least complex tasks. OECD (2014), PISA 2012 results: What students know and can do, student performance in mathematics, reading and science Volume 1
21 DG Education and Culture (2013). PISA 2012: EU performance and first inferences regarding education and training policies in Europe
22 Information and communications technology professionals (ISCO/SOC 25) are not included in this figure. In the data tables, Cedefop groups together these occupations with business and other professional occupations (SOC 24, 25 and 26).
23 Cedefop (2014), Statistics & Indicators: Rising STEM
24 EU Skills Panorama (2014) Science and engineering professionals Analytical Highlight
25 EU Skills Panorama (2014) Science and engineering associate professionals Analytical Highlight
26 Working in science and technology is defined as working in a professional occupation (ISCO/SOC 2) or a technician and associate professional occupation (ISCO/SOC 3).
27 Luxembourg is excluded due to data restrictions
28 I. Dobson (2014), STEM: Country Comparisons – Europe...a critical examination of existing solutions to the STEM skills shortage in comparable countries
29 Cedefop (2014), Statistics & Indicators: Rising STEMs
30 Eurostat (2014), Mathematics, science and technology enrolments and graduates 2008-2012 [educ_thflds]
31 ibid
32 UNESCO (2014), Global alliance launched for Science, Technology, Engineering and Mathematics
33 European Commission (2014), Mapping and analysing bottleneck vacancies in EU labour markets: overview report final
34 ibid
35 Accenture for the European Business Summit (2012), Turning the tide: How Europe can rebuild skills and generate growth
36 BusinessEurope (2012), Plugging the skills gap: The clock is ticking (science, technology and maths)
37 CBI and Pearson (2013), Changing the pace: CBI/Pearson education and skills survey 2013
38 DG Research, (2012), Assessment of impacts of NMP technologies and changing industrial patterns on skills and human resources: Final report
39 G20-OECD-EC Conference on Quality Apprenticeships for Giving Youth a Better Start in the Labour Market (2014), Background paper prepared by the OECD
40 ThinkYoung (2014), Skills Mismatch in Science Technology, Engineering, Mathematics
41 BusinessEurope (2012), Plugging the Skills Gap: The clock is ticking (science, technology and maths)
42 CBI and Pearson (2013), Changing the pace: CBI/Pearson education and skills survey 2013
43 OECD (2012) Connecting with Emigrants, A Global Profile of Diasporas

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