### SUMMARY

#### Overview
- 2.7 million people, 1.25% of the EU workforce (2011), work in the ICT sector (computer programming, consultancy and related activities)
- Employment growth in the sector was 29% between 2000 and 2010
- Above average growth for the ICT sector is forecast to 2020

#### Demand
- ICT sector companies and jobs are unevenly distributed across EU Member States and regions
- Relative to the size of the overall workforce, employment in the ICT sector is highest in Denmark, Sweden and Ireland and smallest in Bulgaria, Romania and Greece
- There has been modest growth in employment in countries and regions with well-established sector presence, with more significant growth in countries and regions ‘catching up’
- There is evidence of a general up-skilling across ICT sector occupations (demand for low-end developers and database administrators to be replaced by demand for business analysts, sales specialists and high-end developers)

#### Supply
- The workforce is predominantly male and young, with little change in the characteristics of the workforce composition since 2000
- Future technical skills supply challenged by the fall in the number of computing graduates across the EU-27

#### Mismatches
- Prior to the recent crisis, skills shortages and gaps in the ICT sector have been widely reported in various EU countries
- The impact of the crisis may have reduced the extent of such shortages
- But key skills gaps still evident and concern:
  - High level job-specific skills of ICT professionals (the design and development of advanced services)
  - Soft skills (managerial, customer oriented skills, communication)
  - As the demand for specialist skills evolves quickly – the risk of skills obsolescence is high. Continuous professional up-skilling and development are essential.
1. A significant sector in the economy and labour market

The ICT sector plays an important role in the economy in its own right and as a vital supplier to the private, public and third sectors - the ‘ICT user industries’. As information and communication technologies have expanded across virtually all economic sectors, the boundaries of the sector are difficult to draw. National statistical definitions of the ICT sector differ.\(^1\) In some contexts, the ICT sector is viewed ‘as a combination of manufacturing and services industries that capture, transmit and display data and information electronically’.\(^2\) The international statistical classification system NACE treats the manufacturing of computers and computer programming, consultancy and related activities as separate sectors.\(^3\)

This Analytical Highlight focuses on the core ICT sector covering computer programming, consultancy and related activities\(^4\), providing a range of ICT services and solutions to the ‘ICT user industries’. A large share of the sector’s workforce is made up of ICT professionals whose tasks include consulting activities and the design of ICT services, ICT development (including software and applications, systems development, web design, security, etc.) and running or delivering ICT services (user support, systems and network administrations, database management, etc.).\(^5\) It is important, however, to distinguish between ICT professionals\(^6\) and the ICT sector. The ICT sector employs ICT professionals and a large number of non-ICT professionals across a range of roles, for example sales and marketing, administrative, finance and human resources. Whilst the ICT sector

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\(^1\) Definitions used by national statistical services for the “ICT sector” vary across European countries and sometimes include manufacturing of computer and computing services.

\(^2\) OECD (2002).

\(^3\) In the NACE 1.1 classification used before 2008, Division 72 (Computer and related activities) includes consultancy activities for hardware or software, publishing of software, data processing activities, database activities and the maintenance and repair of office and information technology machinery. It does not cover computer manufacture (NACE 30.02), nor wholesaling, retailing, or renting (NACE 51.84, 52.48 and 71.33).

Within the NACE Rev 2 classification since 2008, Computer programming, consultancy and related activities (Division 62) only includes writing, modifying, testing and supporting software; planning and designing computer systems that integrate computer hardware, software and communication technologies; on-site management and operation of clients’ computer systems and/or data processing facilities; and other professional and technical computer-related activities. Part of the activities classified in Division 63.1 (Information service activities) can also be considered as belonging to the ICT sector, such as data processing, hosting and related activities and web portals.

\(^4\) As defined in unit group 62 in NACE Rev.2 classification version.

\(^5\) Relevant sources of information concerning the manufacturing, maintenance and repair of computers, the broader ‘information and communication sector’ and ICT professionals (across all sectors) have also been reviewed to inform this paper.

\(^6\) Defined in the International Standard Classification of Occupations (ISCO-08) as occupation group 25 ‘Information and communications technology professionals’, see ISCO-08 classification available at http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm. In the previous ISCO classification (ISCO-88), the key relevant occupation group was 213 ‘Computing Professionals’.
remains the single largest sector employing ICT professionals, in the EU, 55% of ICT professionals work outside the core ICT sector.\(^7\)

Around 2.7 million people in the EU worked in the ICT sector, in computer programming, consultancy and related activities in 2011, accounting for 1.25% of the entire workforce.\(^8\) In 2009, the sector consisted of around 450,000 enterprises, many of which were micro enterprises or small and medium sized enterprises (SMEs). The average number of employees per enterprise was 5.4.\(^9\) ICT sector companies and jobs are not evenly distributed across EU countries and regions (see Figure 1). In absolute terms, the computer programming and consultancy sector is most developed in the United Kingdom and Germany accounting for one million jobs (representing 37% of the entire EU workforce in the sector). However, relative to the total workforce, it is in Denmark, Sweden and Ireland where the sector has the largest share of the entire workforce (2% or more) while in Bulgaria, Romania and Greece, the sector’s contribution to total employment is 0.5% or less.

**Figure 1 – Computer programming, consultancy and related activities as a share of total employment, 2011**

Historically, employment in the sector has been and remains predominantly male. In 2011, only 22% of employees were women and this has not changed in the last

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\(^8\) Eurostat, table [lfsa_egan22d]

\(^9\) Eurostat [sbs_na_1a_se_r2].
decade. The Czech Republic, the Netherlands and Norway are among the countries where the proportion of women in the sector is below the EU average. The age profile of employees in the sector is relatively young, with only 13.7% of the workforce in 2011 aged 50-64 compared to 26.1% across the entire economy.

2. General upskilling, quickly changing demand for specialist skills and the need for a range of non-technical and soft skills

The ICT sector relies on a mix of hard technical and soft skills among its workforce, with a trend towards general up-skilling across the different categories of ICT occupations.\(^\text{10}\) The numbers of less knowledge intensive ICT jobs are expected to fall as the structure of skills demand changes. The demand for low-end developers and database administrators are expected to be replaced by demand for business analysts, sales specialists and high-end developers. There has been a shift in the skills mix of the sector with lower-skilled jobs being replaced by higher-skilled jobs and that up-skilling is expected to continue in the foreseeable future.\(^\text{11}\)

As demand for specialist skills evolves very quickly in the ICT sector, the risk of skills obsolescence is particularly important. Recently, growing needs have been identified for ‘hard’ ICT professional skills in fields such as data privacy, server technology, general networking and network infrastructure. For example in the UK, studies have identified increased demand for ICT professionals with technical skills especially those linked to Microsoft products (NET/ASP.NET, Dynamics, SharePoint, Visual Basic/Visual Studio, C#), PHP and WMWare.\(^\text{12}\) Due to the increased application of ICT across all economic sectors, specialist ICT technical skills are becoming increasingly transferable outside the core ICT sector increasing demand and competition for skills.

According to both European and national evidence, a range of soft skills will become increasingly important for both ICT specialists and the rest of the sector’s workforce. In the UK, interpersonal skills and sales-related skills are seen as key shortages by ICT sector employers.\(^\text{13}\) The key non-IT skills in demand in the ICT sector include:

- Business skills – including creativity and innovation, customer service skills and sales
- Project management and administration – including organisational, managerial and financial skills

\(^{10}\) Software and applications developers and analysts (who research, plan, design, write, test, provide advice on and improve information technology systems, and include systems analysts, software developers, web and multimedia developers and applications programers), database and network professionals (who design, develop, control, maintain and support the optimal performance and security of information technology systems and infrastructure and include such roles as database designers and administrators, systems administrators and computer network professionals).


\(^{12}\) E-Skills UK (2012).

\(^{13}\) E-Skills UK (2012).
Information and Communications Technologies (ICT) sector

November 2012

- Communication – including verbal and written presentation to internal and external audiences, ability to work collaboratively with other employees;
- Foreign language skills.14

3. Current and forecast labour and skills demand in the ICT sector

3.1. Continuous employment growth since 2000

Across the EU, the sector has experienced continuous growth. Between 2000 and 2011, the sector gained around 600,000 additional workers - a growth of 29% (see Figure 2). However, the trend across individual countries differs significantly, from substantial sector growth in Slovenia, Slovakia and Portugal to zero growth in the UK, Romania and Italy and a small decline in Denmark and Iceland. Some countries have mature ICT sectors, whereas in others the sector has only recently developed.

Figure 2 - Growth in employment in computer programming, consultancy and related activities, 2000-2011 (%)

Source: Eurostat, Labour Force Survey, tables [lfsa_egan22d] and [lfsa_egana2d].

3.2. Increasing demand for ICT professionals in the sector

Recent recruitment trends in the ICT sector reveal an increasing demand for ICT professionals, as demonstrated in the following country examples:

- In Belgium, 71% of ICT sector enterprises reported serious problems in filling vacancies and retaining staff.15 Small ICT enterprises require sales

representatives, analysts/programmers, project leaders and IT technicians while the larger ICT enterprises require developers/analysts programmers and IT project leaders.

- In Ireland, vacancies in the sector have increased notably since the 2008 global financial crisis. Vacancies are reported for programmers and software developers, network experts, IT business analysts, architects and systems designers, IT project managers and multilingual IT technical support.\(^\text{16}\)

- In Italy, almost four fifths of total hires in the ICT sector in 2011 were in high skilled occupations.\(^\text{17}\)

- In Slovakia, ICT companies in the eastern Slovakia region planned to increase the number of workers by 40.4% in 2009 (some 1,068 new jobs).\(^\text{18}\) In absolute terms, most new jobs were expected for IT technicians, programmers and testers.

- In Slovenia, computer engineers were the ninth most sought after occupation in 2011.\(^\text{19}\)

- In Norway, quarterly ICT industry job vacancies grew by 35% from an average of 2,300 in 2010 to 3,100 in 2011.\(^\text{20}\)

3.3. A fast growing sector shaped by national development paths and global trends

Future developments in the ICT sector will be largely shaped by the following factors:

- The current pathway of development and growth of the ICT sector in each country
- The speed of technological developments and the diffusion of ICT-based innovation
- The level of public and private decisions to step up ICT investments
- Globalisation and general economic trends.

There are important structural differences between countries in relation to skills demand in the ICT sector.\(^\text{21}\) The demand for skills is likely to be stronger in those countries which are 'lagging behind' and where the economy is less mature in terms of the adoption and diffusion of ICT, and which therefore are expected to experience relatively greater growth in demand for computer programming, consultancy and related services.

In other countries where the ICT sector has grown substantially in recent decades, growth will continue but is expected to remain modest. For example, the ICT consultancy services sector is expected to remain relatively stable in Denmark after having experienced a 30% increase since 2005.\(^\text{22}\) Similarly in the UK, the ICT

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\(^{16}\) FAS (2012).

\(^{17}\) Sistema Informativo Excelsior (2012).

\(^{18}\) Košice IT Valley (2009).

\(^{19}\) Statistical Office of the Republic of Slovenia (2012).

\(^{20}\) NAV (2012).

\(^{21}\) E-Skills Monitor (2010).

\(^{22}\) Statistics Denmark (2012).
services market is mature and largely saturated and further investment and innovation will be the key to maintaining or growing markets. In Norway, the ICT sector has turned into one of the country’s flagship industries and is expected to continue as such.

The long-term impact of the current recession on the ICT sector is relatively hard to assess, past evidence suggests that ICT sector growth rates do follow general economic trends, however, the sector has recently performed better than the overall economy. Indeed, ICT companies were better equipped to deal with the current recession by comparison with the situation observed after the 2001 ‘dot-com’ crisis.

The computing services sector will continue to expand in the EU. Employment growth of 7.6% is forecast, from 3 million workers in the sector in 2010 to 3.2 million in 2020. Compared with the average of 3.4% employment growth forecast across all sectors, ICT will be one of the fastest growing sectors in Europe.\(^\text{23}\)

Emerging demand for ICT services in countries located outside ‘mature’ European markets could lead ICT companies to open new research centres and branches in these new markets. Off-shoring of ICT services is also considered to be an important trend for the sector. While the manufacturing of computer hardware has been off-shored for some time, the relocation of the ICT service industry outside Europe is a more recent phenomenon. The growth of off-shoring activities depends on several factors such as the availability of skills in the offshore location, local ICT infrastructure and the success of developments such as cloud computing or utility computing and whether or not services are suitable to be provided from a distance. Off-shoring of ICT services is expected to remain relatively limited as a proportion of overall ICT services revenues. The impact of off-shoring on the European ICT sector labour market thus far has not been negative as indeed, the sector has expanded at the same time as relocations have taken place. Going forward, the EU is more likely to off-shore mature, low value added ICT services (with lower profit margins) to non-EU countries while exporting higher value added new and innovative ICT services.

In the medium term, the outlook for the ICT sector will remain positive, as demonstrated by these country examples:

- In **Cyprus**, the ICT sector is expected to be one of 10 high growth sectors. Employment in the sector is expected to grow by 3.4% per year between 2010 and 2020. During this period, there will be increasing demand of 5% per year for ICT managers, 3% per year for Analysts and Programmers and 5% per year for ICT assistant technicians and for PC assistant technicians.\(^\text{24}\)

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\(^{23}\) Cedefop (2012).
\(^{24}\) HRDA (2010).
In France, the ICT sector is expected to create around 81,000 net new jobs during 2010 - 2020, from a base of 534,000 jobs in 2010. The jobs created in the ICT sector are expected to constitute around 5% of the 1.5 million net new jobs anticipated by 2020.

In Ireland, strong growth in the demand for software engineering professionals (42.4%) and computer associate professionals (25%) is anticipated. The ICT sector has to some extent recovered the job losses suffered after the 2008 downturn.

In the UK, after a period of a decline, output levels in the ICT sector are expected to pick up significantly in the coming decade. The net impact on employment is modest in relation to the pre-recession growth. Professional occupations are still expected to dominate the sector. The occupational structure of the sector favours the highest-qualified. This is expected to continue, moving from the current 55% of employees being highly-qualified to 60% by 2020. Intermediate level qualifications are anticipated to fall significantly (to under 20% of the workforce), while the share of low level qualifications are projected to rise slightly.

4. Skills supply in the ICT sector

Levels of ICT skills interest and competence amongst young people provide an indication of the future potential supply of skills for the ICT sector. Students’ access and use of ICT at school has improved since 2000. On average across OECD countries, the percentage of students who reported having a computer at home increased from 72% in 2000 to 94% in 2009. During the same period, Internet access at home grew from 45% to 89%, on average across the OECD. The vast majority of European countries show large increases in students’ self-confidence in being able to undertake high-level ICT tasks. Despite this improvement, a divide in the student access and use of ICT is evident between countries.

As graduates from science, mathematics, engineering and science often move into the ICT sector, their availability is also important for the supply of future potential skills. The supply of tertiary education graduates with STEM skills varies significantly across the countries, with STEM graduates constituting around 11-12% of all graduates in the UK, Germany, Greece and Ireland compared to around 5% in Latvia, Lithuania, Romania and Bulgaria. Importantly, however, across the EU, the number of tertiary education graduates in science, mathematics and computing fields has declined slightly in the 2006-2010 period, from 9.8% in 2006 to 9.1% in 2010. Country-level trends are very different, with significant increases in the number of

26 FAS/ESRI (2010).  
27 UKCES (2012).  
29 Eurostat, table [educ_itertc].
STEM graduates apparent in Malta and Slovenia (albeit from a rather low baseline) and Denmark and Germany, but significant decreases in Belgium, Ireland, Cyprus and Austria.

More directly, a large part of the future technical workforce in the ICT sector is also expected to come from the pool of computing graduates, especially at the tertiary level. However, the annual number of students graduating in computing in the EU-27 has been declining over the last five years, following a peak in 2005-2006 (see Figure 3). Important to note is the variation in the number of graduates by ISCED levels:

- At Level 4 (Post-secondary non-tertiary education - pre-vocational and vocational programme orientation) and Level 5 (first stage of tertiary education) the numbers of graduates have declined in the last five years following a peak in 2005-2006;
- At Level 6 (second stage of tertiary education) the number of graduates has continued to increase throughout the last decade (from 1,839 graduates in 2011 to 3,468 graduates in 2010), although representing relatively low numbers.

Figure 3 - Evolution of the numbers of tertiary education graduates in computing, EU-27, 2001-2010, ISCED levels 4-6

Source: Eurostat, table [educ_grad5].
5. Skills mismatches in the ICT sector

5.1. Macro-level imbalances between the demand for ICT services and the supply of ICT graduates

An insufficient supply of ICT graduates is demonstrated in the following country examples:

- In the **Czech Republic**, the number of university graduates in informatics increased significantly between 2005-2010, and is expected to remain at around 1,100-1,200 graduates per year to 2016.\(^{30}\) In contrast, the demand for ICT sector workers is expected to grow by 31% in the 2010-2020 period (from around 56,000 workers in 2010 to around 73,000 workers in 2020), significantly above the average 2% growth in employment expected across all sectors.\(^{31}\)

- In **Ireland**, a significant gap is anticipated up to 2015 between ICT sector demand and the domestic supply of computing graduates of about 2,000-3,000 and hundreds for electronics graduates.\(^{32}\) Such concerns remain relevant in the post-crisis context and the gap between demand and domestic supply will have to be bridged by an inflow of graduates from outside Ireland.\(^{33}\)

- In **Slovakia**, research in the region of eastern Slovakia suggested that the number of graduates participating in ICT-oriented tertiary study programmes will not cover the growing demand for ICT workers.\(^{34}\) Additionally the brain drain from the region is exacerbating the skills gap.

- In **Sweden**, there is an excess supply of programmers forecast until 2025, after which a shortage is forecast.\(^{35}\)

- In **Iceland**, the expansion of the ICT sector will depend on the availability of computing programming graduates. Currently, the number of graduates in science, mathematics and computing remains low and it has even declined recently (18.2% of all graduates in the academic year 2000-2001 to 15.6% in 2009-2010).\(^{36}\)

It is important however to highlight that across the countries, new cohorts of ICT graduates will only represent part of the workforce joining the sector. For example, in the **UK**, on an annual basis up to 2015 it is expected that 18% (22,600) of the average annual net recruitment needs will be met by tertiary education graduates, compared to 43% from those already in work in other sectors (and 39% from other sources).\(^{37}\)

\(^{30}\) National Training Fund (2008).
\(^{31}\) National Training Fund (2012).
\(^{34}\) Košice IT Valley (2009).
\(^{35}\) Statistics Sweden (2012).
\(^{36}\) Statistics Iceland (2012).
\(^{37}\) E-Skills UK (2012).
5.2. Skills shortages and gaps identified at the firm and individual level

**The existence of hard to fill vacancies**

Prior to the recent economic recession, skills shortages and gaps in the ICT sector have been widely reported in various EU countries. In the Czech Republic, for example, employers have repeatedly reported job vacancies in the ICT sector as hard-to-fill.

Commonly reported hard to fill vacancies concern functions such as help desk or end-user support functions; data centre specialists; network specialists, storage specialists, security specialists, application designers or programmers; system architects, project managers. According to an employer survey across Europe, the types of hard skills that were most difficult to find include ‘networking’ and ‘security’; a shortage of systems architects and project managers were also reported in some countries.

Skills mismatches by country and by type of skills remain a concern for the sector:

- **In Ireland**, currently the recruitment difficulties are evident among computer software engineers, personnel with foreign language skills and ICT technical background, ICT network specialists and engineers, ICT security experts, ICT telecommunications, ICT project managers with technical background; and sales and marketing personnel with IT technical background and relevant industry knowledge.

- **In Italy**, 23.7% of all hires were considered difficult in the ICT sector in 2011, a percentage similar to the share for all sectors. However, recruitment difficulties are more prevalent among computing professionals and computer associate professionals where about one third of hires projected for 2011 were considered difficult.

- **In Norway**, shortages of engineers are reported in the ICT sector and well as skills shortages in software development and data technicians. According to an employer survey in 2012, 17% of ICT firms had to recruit persons with an educational background other than that initially required.

- **In the UK**, according to the 2011 IT employer survey, 11% of IT employers are aware of skills gaps among employees and, of these, one third report this for IT and telecoms staff (34%). Skills gaps are prevalent in large firms and seem to be concentrated in the occupations of programmers / software development professionals and web design / development professionals. Non-technical skills

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38 E-skills Monitor (2010).
40 FAS (2012).
41 Sistema Informativo Excelsior (2012).
42 NAV (2012).
43 National Skills Academy for IT (2011).
Information and Communications Technologies (ICT) sector

November 2012

gaps were also a concern for about two thirds of employers reporting skills gaps. Gaps most commonly mentioned are interpersonal skills and sales-related skills, and to a lesser extent, the ability to align IT activity with business needs and to identify new product/process opportunities enabled by IT and telecoms.

Assuming a continuation of past trends, skills gaps will emerge in relation to high level technical skills among ICT professionals (for the design and development of advanced services) but also in terms of managerial/customer oriented skills. However, a decline in demand may occur for other types of ICT hard skills such as traditional programming, given the introduction of more innovative programming techniques.44

The re-emergence of skills gaps and the rapid evolution of new skills/applications within the sector pose particular challenges for on-going skills development and supply. In these circumstances strong co-operation between ICT companies and the education and training sector is essential to guarantee that learning and development is flexible, up-to-date and rapidly responsive to needs.

Useful resources

European level resources

EU statistics (Eurostat)

- Annual detailed enterprise statistics for services (NACE Rev.2 H-N and S95) [sbs_na_1a_se_r2]
- Employment by occupation and economic activity (from 2008, NACE Rev. 2) [lfsa_eisn2]
- Employment by sex, age and economic activity (from 2008, NACE rev.2) (1 000) [lfsa_egan2]
- Employment by sex, age and detailed economic activity (from 2008, NACE Rev.2 two digit level) (1 000) (lfsa_egan22d)
- Graduates in ISCED 3 to 6 by field of education and sex [educ_grad5]

Publications and reports


Digital competence: identification and European-wide validation of its key components for all levels of learners (DIGCOMP), http://is.jrc.ec.europa.eu/pages/EAP/DIGCOMP.html


44 European Commission (2010). In traditional programming, the programme performs operations on data, while in more innovative programming techniques, the programme instructs objects to perform actions that in turn perform operations on data. This introduces an additional level of abstraction over traditional programming techniques and thus requires different skills sets.
Information and Communications Technologies (ICT) sector


National level resources

Belgium


Cyprus


Czech Republic

Czech Future Skills, www.czechfutureskills.eu


Denmark


France

Information and Communications Technologies (ICT) sector

November 2012

Germany

Ireland


Italy

Lithuania
National platform of programming equipment and services technologies, [http://www.nsstp.lt/projektai/it-kompleksin-programa]

Slovakia

Slovenia


Sweden
Statistics Sweden (2012) Trender och prognoser om utbildning och arbetsmarknad (‘Trends and prognosis for training and labour market’), [http://www.scb.se/Pages/Product___9938.aspx]
UK

Norway

Iceland
Statistics Iceland, http://www.hagstofa.is

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