# Comprehensive sectoral analysis of emerging competences and economic activities in the European Union

# Lot 6: Electromechanical engineering

## Final report

April 2009

Alphametrics

with

ISMERI EUROPA

DG Employment, Social Affairs and Equal Opportunities

Eurofound

*This publication is commissioned under the European Community Programme for Employment and Social Solidarity - PROGRESS (2007-2013).*

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# General introduction

The objective of the study is to identify the likely emergent jobs and related competences (skills needs) in two related, but separate and in some senses significantly different, sectors, namely:

- Manufacture of machinery and equipment (NACE 29) – henceforth referred to as the Machinery and equipment sector
- Manufacture of electrical machinery and apparatus (NACE 31) – henceforth referred to as the Electrical machinery and apparatus sector

The term Electro-mechanical Engineering sector will be used when referring to the two sectors together.

The study is based on a specific methodology[1]. It contains:

- An economic and statistical mapping of the sectors concerned, with a focus on the structure and trends in output and employment, the regional distribution of output and employment, other relevant factors such as the size of enterprises, the age, gender, skills and occupational breakdown of the workforce, as well as the competitiveness of the sectors internationally (steps 3 of the prescribed methodology);
- An analysis of the main drivers of change so far as the sectors are concerned and their implications for employment and competence, with a particular focus on the main skill needs and skill gaps that can be identified (steps 4 and 5 of the prescribed methodology);
- A presentation of plausible scenarios concerning the future development of these industries in the period up to 2020, focusing on the implications for employment and competences (steps 6 and 7 of the prescribed methodology);
- The main strategic choices to meet these skill needs (step 8), including the implications for education and training provisions (step 9);
- Recommendations with respect to the above (step 10).

[1] See *Innovation, Skills and Jobs*

# Part 1 – The economic and statistical mapping of the sectors

## Introduction

The electro-mechanical engineering sector covers a wide range of industries, grouped within two distinct, though somewhat related, NACE 2-digit sectors – Manufacture of machinery and equipment (NACE 29) and Manufacture of electrical machinery and apparatus (NACE 31). These are both ‘catch-all’ sectors covering the production of engineering products and closely related activities which are not covered elsewhere in the classification system. Moreover, each of these two sectors incorporates sub-sectors producing machinery and equipment for very different purposes.

In the Machinery and equipment (NACE 29) sector, these range from the manufacture of engines (other than those used in vehicles or aircraft), pumps and turbines and machinery for specialised and more general purposes to the production of weapons and ammunition and domestic appliances, both electrical (somewhat anomalously) and non-electrical.

In respect of the Electrical machinery and apparatus (NACE 31) sector, they range from the manufacture of electric motors, generators and transformers and equipment for the distribution of electricity to wire and cables, lighting and electrical equipment for engines and vehicles.

These various sub-sectors are characterised by major differences in manufacturing processes, in the applicability of new technology, and in the scope for realising increasing returns in production. They are, accordingly, characterised by similarly large differences in the structure of production, and in the relative importance of firms of different size, as well as by the activities performed in the course of the production process. Nevertheless, there is some similarity in the jobs carried out and, therefore, in the skills and competencies which are needed.

At the same time, there is also some similarity in the nature of the sub-sectors or, more specifically, of the products they produce. A common characteristic is that most sub-sectors provide machinery and equipment for other producers rather than for final consumers, and hence their economic fortunes tend to be affected by investment decisions of their customers rather than by final consumption, although those investment decisions will obviously be influenced by the general state of the economy and the confidence of consumers. One important consequence is that demand for the products of the two sectors generally fluctuates more than GDP in the economy as a whole, recognising that investment goods industries are generally hit first during any actual, or foreseen, downturn in economic activity.

The relationship between changes in the rate of economic growth and changes in the rate of investment is not always close in the short-run, however. Producers may anticipate future growth in demand by expanding their productive capacity in advance of it occurring, or they may delay until the demand actually materialises. Moreover, the rate at which producers replace plant and equipment or update machinery will also be influenced by competitive pressures, from inside or outside the EU.

Developments in the two main divisions cannot be assessed without considering developments in the industries they supply and, consequently, the factors, or drivers, which underlie their developments. These industries, moreover, in many countries – though many fewer than a few years ago – include those which are at least partly, and in some cases mostly, publicly owned and operated and which, accordingly, may be affected in their investment decisions by the policy of the national government in question and the state of public finances rather than by market growth whether actual or prospective. This is particularly the case as regards the electrical machinery and apparatus division in which the manufacture of equipment for the distribution of electricity accounts for a significant share of production, though it is also the case in the machinery and equipment sector, which produces railway engines and steam and gas turbines.

Given the diversity of the activities and products covered by the two sectors, it is inevitable that parts of the analysis focus on the most important sub-sectors in terms of value-added and, more especially, employment. Nevertheless, every effort is made to adopt an overall perspective wherever feasible and relevant. This applies, in particular, to the relative importance of the two sectors for jobs in different parts of the EU, and with respect to the skills and competencies required.

## Outline of analysis

The analysis begins by examining the size of the two sectors in terms of their contribution to value-added and employment in EU Member States and the relative importance of the sub-sectors. It also considers the way that these have changed over time, and more specifically, over the last 10 years.

The second section consider the structure of the two sectors in terms of the division of employment between firms of different size, which reflects the production characteristics of the different activities covered.

It also examines the regional location of the two sectors across the EU, which is linked to the production characteristics, and the extent to which production and employment is concentrated in particular places, which are, therefore, potentially vulnerable to any adverse developments in the sectors which affect jobs. These can stem not only from a downturn in the industry or a loss of competitiveness and a consequent reduction in market shares but also potentially from productivity growth resulting from the introduction of new technology and the spread of more automated methods of production.

In the latter case, however, the wider effects of such job losses on local employment are unlikely to be so severe insofar as the output of the sector is maintained and the companies supplying the plants concerned are not affected. Indeed, if gains in productivity lead to a growth in sales, the supplying companies could even experience an expansion of output and employment so perhaps compensating for the job losses in the sectors concerned.

The third section examines the trade performance of EU producers in the two sectors and, in particular, their relative position in world markets and the extent to which they have lost – or gained – export market share to producers in other countries over recent years. This is relevant to their future prospects, not only for exporting but also for being able to withstand competition from imports in the domestic market.

## Output and employment in the electro-mechanical engineering sector

The two broad sectors which are the subject of the study differ in terms of size and their contribution to output, or value-added, and employment, as do the sub-sectors which make them up. In the EU as a whole, the machinery and equipment industry – NACE division 29 – is just over twice the size of the electrical equipment and apparatus industry – NACE 31 – in terms of both value-added and employment.

According to the latest data (for 2005), the former, therefore, is responsible for just under 2% of the overall output of the EU economy and for a slightly smaller share of total employment, while the latter accounts for just under 1% of output and again a slightly smaller proportion of total jobs in the economy. These figures, however, vary markedly between countries.

## Machinery and equipment sector (NACE 29)

### Value-added

In Germany, the machinery and equipment industry accounts for some 3.4% of value-added, in Finland for 2.8%, and in Sweden, Italy and Austria for around 2.5% (Table 1 – no data are included for either Cyprus or Malta where the sector is very small). Denmark apart (where the figure is just over 2%), these figures are significantly higher than in other EU15 countries, in most cases, over twice as high. In France and the UK, as well as and Spain, the sectors is responsible for only just over 1% of overall value-added in the economy.

In the new Member States, the relative importance of the sector for output varies equally as much. In the Czech Republic and Slovenia, the sector accounts for 2.6% of overall value-added in the economy – much the same as in the leading EU15 countries apart from Germany – and in Slovakia, for just under 2%,. In Hungary, Poland and Bulgaria, it accounts for 1.5%, and in Romania, for just over 1%, much the same as in France and the UK. In the other 5 countries, the sector contributes well under 1% of total output.

### Value-added and employment compared

The contribution of the sector to jobs differs from that of value-added in a number of countries, reflecting differences in labour productivity compared with other parts of the economy, which in turn in part reflects differences in the composition of the sector in terms of the relative weight of the different products produced. There is, however, no systematic pattern in this across the Union.

In 5 EU15 countries, including Germany, Austria and Sweden, the sector contributes more to value-added than to employment, indicating a higher level of labour productivity than in other sectors. In 8 countries, including Greece, Spain and Portugal but also Denmark and Finland, the reverse is the case, indicating a lower level of productivity, while in France and the UK, it is the same.

In all of the new Member States, with the sole exception of Poland if the three Baltic States, where the industry is relatively unimportant, are left to one side, the sector’s contribution to employment is greater than its contribution to value-added. Labour productivity in the sector is, therefore, relatively low as compared with other parts of the economy. This is particularly the case in Romania and Bulgaria, where the sector accounts for some 2% of employment, while in the Czech Republic and Slovenia, it accounts for around 3% of the total, more than in Germany.

**Table 1 Value-added and employment in the machinery and equipment sector (NACE 29)**

| | Value-added % total 1995 | 2005 | % point change 1995-05 | Employment % total 1995 | 2005 | % point change 1995-05 |
|---|---|---|---|---|---|---|
| **EU27** | 2.2 | 1.9 | -0.3 | 2.1 | 1.8 | -0.3 |
| **EU15** | 2.2 | 1.9 | -0.3 | 2.0 | 1.7 | -0.3 |
| **NM12** | 1.8 | 1.5 | -0.2 | 2.3 | 1.9 | -0.4 |
| **BE** | 1.2 | 1.1 | -0.1 | 1.1 | 0.9 | -0.2 |
| **BG** | 1.3 | 1.6 | 0.3 | | 2.0 | |
| **CZ** | 2.7 | 2.6 | -0.2 | 3.6 | 3.1 | -0.5 |
| **DK** | 2.7 | 2.1 | -0.6 | 2.7 | 2.2 | -0.5 |
| **DE** | 3.3 | 3.4 | 0.1 | 3.1 | 2.7 | -0.3 |
| **EE** | | | | | 0.5 | |
| **IE** | 1.2 | 0.6 | -0.6 | | 0.7 | |
| **GR** | 0.4 | 0.4 | -0.1 | | 0.6 | |
| **ES** | 1.1 | 1.1 | 0.0 | 1.1 | 1.2 | 0.1 |
| **FR** | 1.6 | 1.2 | -0.4 | 1.5 | 1.2 | -0.3 |
| **IT** | 2.6 | 2.5 | 0.0 | 2.5 | 2.6 | 0.1 |
| **LV** | | 0.6 | | | 0.6 | |
| **LT** | 1.0 | 0.7 | -0.2 | 0.0 | 0.6 | 0.6 |
| **LU** | 1.1 | 0.7 | -0.4 | 1.4 | 1.4 | 0.0 |
| **HU** | 1.6 | 1.5 | -0.1 | 2.3 | 1.7 | -0.6 |
| **NL** | 1.3 | 1.3 | 0.0 | 1.1 | 1.2 | 0.1 |
| **AT** | 2.1 | 2.4 | 0.3 | 1.9 | 2.0 | 0.1 |
| **PL** | 1.5 | 1.5 | 0.0 | 1.7 | 1.3 | -0.4 |
| **PT** | 0.8 | 0.8 | 0.0 | 1.0 | 1.0 | 0.0 |
| **RO** | | 1.2 | | | 1.9 | |
| **SI** | 2.1 | 2.6 | 0.5 | 3.4 | 2.9 | -0.5 |
| **SK** | 2.4 | 1.9 | -0.6 | 4.0 | 2.3 | -1.7 |
| **FI** | 2.9 | 2.8 | -0.1 | 2.7 | 3.1 | 0.3 |
| **SE** | 2.8 | 2.6 | -0.2 | 2.4 | 2.3 | -0.1 |
| **UK** | 1.9 | 1.2 | -0.7 | 1.6 | 1.2 | -0.5 |

*Source: Eurostat. National accounts and authors' estimates*

In the EU as a whole, the contribution of the machinery and equipment industry to output declined over the 10 years 1995-2005, as it did in manufacturing as a whole. This was the case in most Member States, both in the EU15 and among new entrants.

The only countries, in which the value-added generated by the sector increased over this period relative to that in other parts of the economy were Germany – marginally – and Austria among the EU15 and Bulgaria and Slovenia among the new Member States. In Spain, Italy, the Netherlands and Portugal, as well as in Poland, however, the contribution remained much the same. The reduction in value-added relative to the rest of the economy was particularly marked in Denmark, Ireland, the UK and Slovakia.

The decline in the sector’s contribution to employment over the period was on a similar scale, though larger in the new Member States, reflecting the high rate of productivity growth. Only in Finland and marginally in Spain, Italy, the Netherlands and Austria was there an increase in the sector’s share of total employment.

## Electrical equipment and apparatus sector

### Value added

Value-added and employment in the electrical manufacturing and apparatus sector differs somewhat from the machinery and equipment sector. However, there is some tendency for the countries in which the latter is important to be the same as those in which the former is important, though with some notable differences. The apparent trends also differ. In particular, while there is no evidence of any significant shift of production to the new Member States in the case of machinery and equipment, such a shift seems to have occurred in the case of the production of electrical equipment and apparatus.

The contribution of the latter to output tends to be larger in the new Member States than in the EU15. Only in Germany, Finland and Sweden among EU15 countries does the electrical equipment and apparatus sector account for more than 1% of total output in the economy and only in Germany to close to 2% (Table 2). In Italy, unlike in the case of mechanical engineering, the value-added generated by the sector accounts for well under 1% of total output, which is also true for France and the UK.

**Table 2 Value-added and employment in the electrical equipment and apparatus sector (NACE 31)**

| | Value-added % total | | % point change | Employment % total | | | % point change |
|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001-05 | 1995 | 2001 | 2005 | 1995-05 |
| **EU27** | 0.9 | 0.9 | 0.0 | 0.9 | 0.9 | 0.8 | -0.1 |
| **EU15** | 0.9 | 0.9 | 0.0 | 0.9 | 0.8 | 0.7 | -0.2 |
| **NM12** | 1.3 | 1.3 | 0.0 | 0.7 | 1.0 | 1.1 | 0.3 |
| **BE** | 0.7 | 0.4 | -0.3 | 0.7 | 0.7 | 0.4 | -0.3 |
| **BG** | 0.5 | 0.6 | 0.1 | | 0.6 | 0.5 | |
| **CZ** | 1.7 | 2.0 | 0.3 | 1.5 | 2.2 | 2.2 | 0.7 |
| **DK** | 0.9 | 0.8 | 0.0 | 0.8 | 0.8 | 0.8 | 0.0 |
| **DE** | 1.7 | 1.9 | 0.2 | 1.6 | 1.4 | 1.3 | -0.3 |
| **EE** | 0.5 | 0.8 | 0.3 | | 0.5 | 0.8 | |
| **IE** | 1.4 | 0.5 | -0.9 | | 0.8 | 0.5 | |
| **EL** | 0.2 | 0.2 | 0.0 | | 0.1 | 0.2 | |
| **ES** | 0.6 | 0.5 | -0.1 | 0.6 | 0.7 | 0.5 | -0.1 |
| **FR** | 0.6 | 0.7 | 0.1 | 0.6 | 0.6 | 0.6 | 0.0 |
| **IT** | 0.8 | 0.7 | -0.1 | 0.9 | 0.9 | 0.9 | -0.1 |
| **LV** | 0.3 | 0.3 | 0.0 | 0.3 | 0.3 | 0.3 | 0.0 |
| **LT** | 0.3 | 0.6 | 0.2 | 0.3 | 0.3 | 0.5 | 0.2 |
| **LU** | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.2 | 0.0 |
| **HU** | 1.9 | 2.1 | 0.3 | 1.2 | 2.1 | 1.8 | 0.6 |
| **MT** | 1.0 | 1.0 | 0.0 | | 0.9 | 0.8 | |
| **NL** | 0.3 | 0.2 | -0.1 | 0.3 | 0.3 | 0.2 | -0.1 |
| **AT** | 0.9 | 0.8 | -0.2 | 0.7 | 0.7 | 0.7 | -0.1 |
| **PL** | 1.0 | 0.8 | -0.2 | 0.5 | 0.6 | 0.7 | 0.2 |
| **PT** | 0.5 | 0.5 | 0.0 | 0.7 | 0.7 | 0.5 | -0.1 |
| **RO** | 0.7 | 0.6 | -0.1 | | 0.7 | 1.0 | |
| **SI** | 1.4 | 1.8 | 0.4 | 1.5 | 1.6 | 1.7 | 0.1 |
| **SK** | 1.5 | 2.0 | 0.4 | 1.7 | 2.0 | 2.5 | 0.8 |
| **FI** | 0.7 | 1.4 | 0.7 | 0.6 | 0.8 | 0.7 | 0.1 |
| **SE** | 1.4 | 1.2 | -0.2 | 0.8 | 0.8 | 0.5 | -0.3 |
| **UK** | 0.7 | 0.5 | -0.2 | 0.7 | 0.6 | 0.5 | -0.2 |

*Source: Eurostat National acounts and Structural Business Statistics plus authors' estimates*

In the new Member States, by contrast, the value-added produced by the sector amounts on average to 1.3% of output in the economy – more than in any EU15 country apart from Germany and Finland – in the Czech Republic, Hungary and Slovakia, to 2%, and to only slightly less than this in Slovenia.

Moreover, in all four of these countries, the contribution of the sector to overall output in the economy increased significantly over the four years 2001-2005, as it did in Estonia and Lithuania. Although this is a short period over which to assess trends – inevitably so because of the lack of consistent data for the years before 2001[2] – it, nevertheless, is indicative of the shift in the industry which seems to be occurring. By contrast, apart from in Germany, Finland and marginally in France, the share of value-added produced by the sector either declined or remained unchanged over this period in all EU15 countries.

### Value added and employment compared

Unlike the mechanical engineering industry, the share of total employment accounted for by the electrical machinery and apparatus sector is either similar to, or less than, its share of value-added in almost all Member States, reflecting the relatively high level of labour productivity compared with other parts of the economy. The only exceptions are Italy, the Czech Republic, Slovakia and Romania. Productivity is especially high in the three EU Member States where the sector contributes most to value-added, Germany, Finland and Sweden.

The sector's share of total employment declined in all EU countries over the 10 years 1995-2005 apart from in Finland (where value-added rose markedly between 2001 and 2005 and where there was a small increase in employment) and Denmark and France (where employment remained unchanged). In marked contrast, employment rose over this same period in all the new Member States for which data are available, emphasising the shift in the industry from one part of the EU to another. (It also rose in Estonia and Romania, for which there are data only for the latter part of the period.)

### Numbers in employment in the sector

In terms of absolute numbers, the EU electro-mechanical sector as a whole is estimated to have employed over 5.5 million people in 2005. Of these, some 3.8 million were in the machinery and equipment sector, and around 1.7 million in the electrical equipment and apparatus sector (Table 3). Just under 1.6 million of the 5.5 million total were in Germany (just under 30% of the total), while almost 1.3 million were in the new Member States.

Both Germany and the new Member States accounted for a larger share of employment in the electrical equipment sector than the machinery sector, with well over half (56%) of all the EU jobs in the former sector being located in these countries - 29% in Germany and 27% in the new Member States. Germany alone was responsible for almost 40% of total employment in electrical engineering in the EU15 in 2005 (well above its share of employment in manufacturing as a whole – 27%).

Over the 10 years 1995-2005, the two parts of the electro-mechanical sector experienced differing fortunes. In the first half of the period – namely from 1995 to 2000 - when there was a relatively high rate of both GDP and employment growth in the EU, if less so in the

[2] The estimates of value-added are based on the Structural Business Statistics which are reasonably consistent for the period 2001 to 2005 but less so for earlier years.

new Member States, the number employed in the machinery and equipment sector in the EU as a whole declined by an average of 0.3% a year, more than the slight fall in manufacturing as a whole.

In the EU15, however, the number employed in the industry rose marginally, even though it fell significantly in Germany. The fall was even larger in the new Member States, however, averaging an estimated 1.6% a year.

In the electrical engineering industry, by contrast, the number employed in the EU increased at much the same rate as in the economy as a whole. The increase was particularly high in the new Member States, while employment in the industry declined in Germany.

Over the next five years – from 2000 to 2005 - the numbers employed in both sectors fell sharply in the EU, by just over 1% a year, much the same as the fall in manufacturing as a whole, while total employment in the economy continued to grow, if at a lower rate than before.

Despite the similarity in the rate of job decline in the two sectors, however, the distribution of the job losses varied markedly across the EU. Employment in machinery and equipment fell in most parts of the EU between 2000 and 2005, and more in the new Member States than in EU 15 countries. On the other hand, the loss of jobs in electrical equipment and apparatus was concentrated in the EU15 with numbers employed in the new Member States increasing by 2.6% a year – much the same rate as the decline in the EU15.

Moreover, although the fall in employment in the electrical equipment sector in EU15 countries can be seen in part as a consequence of slow EU growth in 2001-2003 following the EU recession, there is little evidence of any subsequent recover, with employment continuing to decline significantly after 2003, while the rate of job growth in the new Member States has increased still further – to 3% a year.

In the machinery and equipment sector, the numbers employed in EU15 countries also continued to fall after 2003 and at a slightly higher rate than before. In the new Member States, however, it did increase slightly, perhaps reflecting a belatedly shift of production to these countries.

In overall terms, therefore, the evidence suggests a somewhat slower rate of decline in employment in the EU as a whole in the two sectors than in manufacturing since 2003, though still a decline, coupled with a shift in jobs towards the new Member States, a shift which also seems to be occurring in manufacturing as a whole.

In the electrical equipment sector, this overall decline in employment is largely a result of a relatively high rate of productivity growth, given that value-added has tended to remain broadly unchanged in relation to output in the economy as a whole. In the machinery sector, however, this is not the case since its share of value-added has declined along with employment.

**Table 3 Employment in the Electro-mechanical engineering sector**

| | Number employed (000s) | | | Change in employment (% pa) | | | |
|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2005 | 1995-2000 | 2000-05 | 2000-03 | 2003-05 |
| **Machinery and equipment** | | | | | | | |
| EU27 | 4110 | 4051 | 3826 | -0.3 | -1.1 | -1.4 | -0.7 |
| EU15 | 3114 | 3133 | 3014 | 0.1 | -0.8 | -0.7 | -0.9 |
| DE | 1159 | 1119 | 1063 | -0.7 | -1.0 | -0.6 | -1.7 |
| IT | 536 | 587 | 626 | 1.8 | 1.3 | 1.6 | 0.8 |
| Other EU15 | 1419 | 1427 | 1325 | 0.1 | -1.5 | -1.7 | -1.1 |
| NM12 | 996 | 918 | 812 | -1.6 | -2.4 | -4.2 | 0.3 |
| **Electrical equipment and apparatus** | | | | | | | |
| EU27 | 1723 | 1823 | 1723 | 1.1 | -1.1 | -1.4 | -0.7 |
| EU15 | 1407 | 1419 | 1264 | 0.2 | -2.3 | -2.5 | -2.0 |
| DE | 586 | 553 | 499 | -1.1 | -2.0 | -2.6 | -1.2 |
| IT | 207 | 209 | 210 | 0.2 | 0.1 | 1.1 | -1.2 |
| Other EU15 | 614 | 657 | 554 | 1.4 | -3.4 | -3.6 | -2.9 |
| NM12 | 316 | 404 | 460 | 5.0 | 2.6 | 2.4 | 3.0 |
| **Total manufacturing** | | | | | | | |
| EU27 | 38905 | 38732 | 36388 | -0.1 | -1.2 | -1.2 | -1.3 |
| EU15 | 29691 | 29568 | 27463 | -0.1 | -1.5 | -1.3 | -1.8 |
| DE | 8443 | 8109 | 7506 | -0.8 | -1.5 | -1.5 | -1.6 |
| IT | 5065 | 5005 | 4941 | -0.2 | -0.3 | 0.4 | -1.3 |
| Other EU15 | 16183 | 16454 | 15016 | 0.3 | -1.8 | -1.7 | -2.0 |
| NM12 | 9214 | 9164 | 8925 | -0.1 | -0.5 | -1.0 | 0.2 |
| **Total in economy** | | | | | | | |
| EU27 | 197847 | 209426 | 216464 | 1.1 | 0.7 | 0.6 | 0.8 |
| EU15 | 155142 | 166870 | 174102 | 1.5 | 0.9 | 0.9 | 0.8 |
| DE | 37601 | 39144 | 38846 | 0.8 | -0.2 | -0.4 | 0.2 |
| IT | 21841 | 22930 | 24333 | 1.0 | 1.2 | 1.7 | 0.4 |
| Other EU15 | 95700 | 104796 | 110923 | 1.8 | 1.1 | 1.1 | 1.2 |
| NM12 | 42705 | 42556 | 42362 | -0.1 | -0.1 | -0.6 | 0.6 |

*Source; Eurostat, National accounts and Structural Business Statistics plus authors' estimates. Note that the figures for the two sectors involve some estimation and should therefore be regarded as approximate only.*

## Composition of the electro-mechanical sector

Differences in experience across the EU partly reflect differences in the composition of the sector in different Member States. As previously noted, the electro-mechanical sector is composed of a range of sub-sectors manufacturing very different types of product, which vary in terms of their technical features, and in the nature and degree of competition in global markets.

### Machinery and equipment

In the machinery and equipment sector, three broad types of product account for over three-quarters of total output at EU level. These are:

- Engines, turbines, pumps, compressors and other equipment involved in the production and use of mechanical power, such as bearings or gears (i.e. the products included in NACE 29.1);
- General-purpose machinery, such as lifting gear, furnaces and ovens, cooling and ventilation systems and weighing and vending machines (the products in NACE 29.2);

- Special-purpose machinery, such as for iron and steel manufacture, mining, construction, food and drink manufacture and textiles and clothing production (those including in NACE 29.5) (Table 4).

These three sub-sectors are of a similar size, each producing between 23% and 30% of the industry's output. The other four sub-sectors between them - which produce tractors and agricultural equipment, machine tools, weapons and ammunition and domestic appliances - are responsible for only just over 20% of the output, with machine tools (9%) and domestic appliances (7%) being the most important among these.

The division of employment between sub-sectors is similar to that of value-added, the main exceptions being that the manufacture of engines, turbines, pumps, etc. accounts for a smaller share of jobs than of output, reflecting the relatively high level of labour productivity, and the greater use of capital.

Although there are variations between Member States in the division of the sector between sub-sectors, the three largest sub-sectors at EU level account for the greater part of value-added and employment in all Member States, with the exception of Slovenia, where the manufacture of domestic appliances accounts for 45% of the value-added of the industry and 40% of employment.

There are, however, differences in the relative importance of sub-sectors, particularly between the EU15 countries and the new Member States. In the latter, the three largest sub-sectors account for only just over 70% of value-added and employment on average, some 7 percentage points less than in the EU15, primarily because of the smaller size of the general-purpose machinery sub-sector, which is offset in some degree by their somewhat higher production of special-purpose machinery and domestic appliances.

This is especially the case in Bulgaria and Romania as well as Slovenia, though in the first, weapons and ammunitions account for a much larger share of value-added than elsewhere[3]. Apart from these three countries, domestic appliances are particularly important in Hungary and Poland, whereas in the EU15, they account for under 10% of value-added in all countries apart from Spain (14%).

Their contribution to employment, however, is smaller in all these countries, in some cases significantly so, reflecting the relatively high level of labour productivity compared with other parts of the sector.

[3] There is a need for caution in interpreting the figures for weapons and ammunition since in many countries, production may be under-recorded.

**Table 4 Division of Machinery and equipment industry (NACE 29) between sub-sectors**

*% Value-added/employment in NACE 29*

| | Engines, turbines, pumps, etc (291) | | General purpose machinery (292) | | Agricultural machinery (293) | | Machine tools (294) | | Special-purpose machinery (295) | | Weapons+ ammunition (296) | | Domestic appliances (297) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| **Value-added** | | | | | | | | | | | | | | |
| **EU27** | 21 | 23 | 29 | 30 | 5 | 5 | 10 | 9 | 27 | 25 | 2 | 3 | 7 | 7 |
| **EU15** | 21 | 23 | 30 | 30 | 5 | 5 | 10 | 9 | 27 | 25 | 2 | 3 | 7 | 7 |
| **NM10** | 21 | 22 | 20 | 21 | 8 | 6 | 9 | 8 | 29 | 28 | 4 | 3 | 10 | 13 |
| **BE** | 25 | 25 | 30 | 30 | 8 | 8 | 4 | 3 | 27 | 27 | 4 | 4 | 2 | 3 |
| **BG** | 24 | 25 | 11 | 13 | 3 | 3 | 10 | 9 | 20 | 21 | 29 | 19 | 3 | 10 |
| **CZ** | 18 | 19 | 23 | 24 | 5 | 5 | 16 | 12 | 31 | 33 | 4 | 3 | 6 | 4 |
| **DK** | 31 | 36 | 33 | 29 | 6 | 8 | 3 | 4 | 21 | 19 | : | : | 6 | : |
| **DE** | 22 | 25 | 26 | 26 | 3 | 3 | 13 | 12 | 28 | 26 | 1 | 1 | 7 | 6 |
| **ES** | 13 | 12 | 34 | 34 | 4 | 4 | 8 | 6 | 27 | 28 | 2 | 2 | 12 | 14 |
| **FR** | 23 | 24 | 33 | 36 | 8 | 7 | 5 | 4 | 22 | 19 | 3 | 5 | 6 | 6 |
| **IT** | 17 | 21 | 31 | 33 | 5 | 5 | 10 | 9 | 26 | 22 | 1 | 1 | 9 | 9 |
| **HU** | 14 | 20 | 30 | 27 | 10 | 7 | 6 | 6 | 23 | 23 | 1 | 1 | 16 | 17 |
| **NL** | 18 | 19 | 39 | 36 | 8 | 7 | 3 | 3 | 30 | 33 | 0 | 1 | 2 | 2 |
| **AT** | 11 | 14 | 28 | 29 | 8 | 7 | 9 | 8 | 37 | 34 | 2 | 2 | 5 | 5 |
| **PL** | 22 | 20 | 19 | 20 | 9 | 8 | 6 | 5 | 31 | 31 | 4 | 3 | 8 | 13 |
| **RO** | 32 | 33 | 6 | 9 | 6 | 5 | 7 | 9 | 33 | 25 | 6 | 4 | 10 | 16 |
| **SI** | 8 | 9 | 20 | 17 | 5 | 4 | 11 | 9 | 13 | 16 | 0 | 0 | 43 | 45 |
| **SK** | 37 | 50 | 13 | 17 | 4 | 3 | 11 | 5 | 26 | 25 | 1 | 1 | 7 | -1 |
| **FI** | 16 | 15 | 27 | 29 | 6 | 10 | 5 | 4 | 43 | 38 | 2 | 2 | 2 | 2 |
| **SE** | 19 | 21 | 32 | 31 | 4 | 4 | 12 | 12 | 24 | 23 | 4 | 4 | 6 | 5 |
| **UK** | 22 | 24 | 34 | 33 | 4 | 2 | 7 | 5 | 20 | 21 | 4 | 8 | 8 | 7 |
| **Employment** | | | | | | | | | | | | | | |
| **EU27** | 19 | 20 | 28 | 29 | 6 | 6 | 9 | 9 | 27 | 26 | 3 | 3 | 8 | 8 |
| **EU15** | 19 | 20 | 30 | 31 | 5 | 5 | 9 | 9 | 27 | 26 | 2 | 2 | 8 | 7 |
| **NM10** | 18 | 19 | 18 | 21 | 8 | 7 | 9 | 9 | 28 | 28 | 9 | 6 | 9 | 10 |
| **BE** | 17 | 18 | 33 | 32 | 8 | 9 | 5 | 4 | 31 | 30 | 3 | 3 | 3 | 4 |
| **BG** | 17 | 21 | 16 | 16 | 5 | 4 | 11 | 10 | 21 | 19 | 26 | 22 | 4 | 7 |
| **CZ** | 16 | 18 | 21 | 24 | 7 | 6 | 13 | 12 | 34 | 34 | 3 | 3 | 5 | 5 |
| **DK** | 30 | 34 | 31 | 30 | 7 | 8 | 4 | 4 | 22 | 20 | : | : | 5 | 4 |
| **DE** | 21 | 22 | 26 | 26 | 4 | 4 | 13 | 13 | 29 | 28 | 1 | 1 | 6 | 6 |
| **ES** | 11 | 11 | 32 | 33 | 6 | 6 | 8 | 6 | 29 | 32 | 2 | 2 | 12 | 11 |
| **FR** | 22 | 22 | 33 | 35 | 9 | 9 | 5 | 4 | 21 | 20 | 2 | 4 | 7 | 6 |
| **IT** | 16 | 17 | 32 | 34 | 6 | 6 | 9 | 9 | 26 | 23 | 1 | 1 | 10 | 10 |
| **HU** | 13 | 15 | 34 | 31 | 11 | 9 | 5 | 6 | 21 | 22 | 1 | 1 | 15 | 15 |
| **NL** | 17 | 18 | 40 | 40 | 9 | 10 | 4 | 3 | 28 | 27 | : | : | : | 2 |
| **AT** | 10 | 13 | 30 | 28 | 9 | 9 | 10 | 9 | 34 | 35 | 2 | 1 | 6 | 5 |
| **PL** | 17 | 16 | 21 | 24 | 10 | 9 | 9 | 7 | 32 | 32 | 4 | 3 | 8 | 9 |
| **RO** | 23 | 25 | 6 | 10 | 8 | 7 | 7 | 8 | 28 | 30 | 22 | 10 | 6 | 10 |
| **SI** | 8 | 8 | 18 | 18 | 7 | 6 | 11 | 10 | 14 | 18 | 0 | 0 | 43 | 40 |
| **SK** | 26 | 36 | 13 | 16 | 7 | 4 | 13 | 8 | 31 | 28 | 2 | 1 | 8 | 7 |
| **FI** | 15 | 14 | 28 | 27 | 7 | 8 | 5 | 5 | 40 | 41 | 2 | 2 | 2 | 2 |
| **SE** | 17 | 17 | 31 | 35 | 4 | 3 | 10 | 8 | 26 | 27 | 4 | 3 | 9 | 7 |
| **UK** | 21 | 23 | 35 | 34 | 4 | 4 | 7 | 5 | 20 | 20 | 4 | 6 | 10 | 9 |

*Source: Eurostat, Structural Business Statistics*

Nevertheless, the new Member States still account for less than 10% of the-total value-added produced by the domestic appliance industry in the EU as a whole, measuring in terms of Euros[4]. At the same time, they account for almost a quarter (24%) of total employment in the industry and for 19% of the total number employed in the machinery and equipment sector as a whole (Table 5).

With respect to other parts of the sector, the machine-tool industry is especially important in Germany, where it accounts for 12% of the value-added of the sector and around 53% of the total value-added generated by the industry in the EU. Since Italy accounts for just under 17% of value-added, this means that close to 70% of the output of machine-tools in the EU takes place in these two countries.

**Table 5 Division of value-added and employment in NACE 29 - EU Member States**

*% Total value-added/employment in the EU*

| | Machinery and equipment (NACE 29) | | Engines, turbines, pumps, etc (291) | | General purpose machinery (292) | | Agricultural machinery (293) | | Machine tools (294) | | Special-purpose machinery (295) | | Weapons+ ammunition (296) | | Domestic appliances (297) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| **Value-added (EUR)** | | | | | | | | | | | | | | | | |
| **EU27** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **EU15** | 96 | 95 | 96 | 95 | 97 | 97 | 93 | 94 | 96 | 96 | 95 | 95 | 91 | 95 | 94 | 91 |
| **DE** | 37 | 37 | 40 | 41 | 33 | 32 | 24 | 26 | 50 | 53 | 39 | 39 | 20 | 20 | 34 | 30 |
| **IT** | 10 | 10 | 11 | 10 | 11 | 12 | 15 | 14 | 5 | 5 | 8 | 7 | 17 | 18 | 22 | 22 |
| **Oth EU15** | 49 | 49 | 44 | 44 | 53 | 53 | 54 | 53 | 40 | 38 | 48 | 48 | 54 | 57 | 38 | 39 |
| **NM10** | 4 | 5 | 4 | 5 | 3 | 3 | 7 | 6 | 4 | 4 | 5 | 5 | 9 | 5 | 6 | 9 |
| **Employment** | | | | | | | | | | | | | | | | |
| **EU27** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **EU15** | 80 | 81 | 81 | 81 | 87 | 86 | 72 | 77 | 80 | 81 | 80 | 80 | 42 | 61 | 78 | 76 |
| **DE** | 29 | 29 | 33 | 33 | 27 | 26 | 18 | 18 | 39 | 43 | 31 | 30 | 9 | 12 | 23 | 21 |
| **IT** | 9 | 9 | 10 | 10 | 10 | 10 | 14 | 13 | 5 | 4 | 7 | 6 | 6 | 12 | 19 | 21 |
| **Oth EU15** | 43 | 44 | 38 | 38 | 50 | 50 | 41 | 46 | 36 | 34 | 42 | 43 | 28 | 37 | 37 | 34 |
| **NM10** | 20 | 19 | 19 | 19 | 13 | 14 | 28 | 23 | 20 | 19 | 20 | 20 | 58 | 39 | 22 | 24 |

*Source: Structural Business Statistics*

The relative importance of the different sub-sectors and the distribution of these between Member States have not changed greatly over recent years. So far as the composition of the sector is concerned, the main tendency is for the share of engines, turbines, pumps and so on to increase along with the share of general-purpose machinery, and for the share of special purpose machinery to decline, though this is more the case for value-added than for employment.

The other main change is for the production of domestic appliances, predominantly electrical ones, to shift to the new Member States. At the same time, Germany is becoming increasingly dominant in the manufacture of machine-tools.

## Electrical equipment and apparatus

In the electrical equipment sector, sub-sectors can be grouped in four blocks:

[4] There is an argument for measuring value-added in purchasing power standard (PPS) terms since this takes account of differences in price levels across countries, though the output of the sector is sold in the European and global market in Euros – or dollars – rather than PPS.

- Electric motors, generators and transformers (the products included in NACE 31.1), which account for some 17% of value-added in the sector;
- Apparatus and control systems for the distribution of electricity, such as switches, fuses, junction boxes and relays as well as control consoles (the products included in NACE 31.2), which account for 39% of sector value-added;
- Electrical equipment not specified elsewhere (NACE 31.6), which includes electrical components for vehicles, signalling equipment and electro-magnets and which account for 25% of value-added;
- The remaining three sub-sectors - insulated wire and cables, batteries and lighting - which account for some 19%, the latter alone accounting for 10% of the total (Table 6).

There are, however, marked differences in the relative weight of the different sub-sectors between Member States and, accordingly, more sign of specialisation than in the case of the machinery and equipment sector. In particular, the manufacture of apparatus for electricity distribution is much more important in EU15 countries than in the new Member States, accounting for 42% on average of the value-added produced by the sector (57% in Germany), as against 15% in the new Member States. The opposite is the case for Lighting equipment and lamps, which is responsible for 27% of the value-added produced by the sector in the new Member States, as against just 8% on average in the EU15.

While there are similarities in the relative weight of sectors in terms of employment as in terms of value-added in different parts of the EU, there are more differences than in the case of the mechanical engineering part of the sector, which may reflect differing areas of specialisation within sub-sectors, especially as between the EU15 countries and the new Member States.

In particular, whereas the manufacture of apparatus for electricity distribution accounts for a larger share of value-added than of employment in EU15 – 42% of value-added generated by the sector but only 18% of employment (reflecting a relatively high level of labour productivity in the industry), the reverse is the case in the new Member States. This could suggest that production in EU15 is concentrated more on larger, higher value-added equipment than in the new Member States.

Similarly, in the manufacture of electric lighting and lamps, which is an especially important sub-sector in the new Member States, the share of value-added (26%) is double the share of employment (13%), whereas in the EU15 countries, the employment share is slightly larger than the value-added share. In Hungary, where 60% of the value-added of the sector is generated by the manufacture of lighting and lamps, it accounts for just 29% of employment, implying that labour productivity is twice as high as the sector average.

**Table 6 Sub-sectors of Electrical equipment and apparatus (NACE 31)**

*% Value-added/employment in NACE 31*

| | Electric motors, generators (311) | | Electricity distibution +control apparatus (312) | | Insulated wire+cable (313) | | Accumulators, batteries (314) | | Lighting +lamps (315) | | Other electrical equipment (316) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| **Value-added** | | | | | | | | | | | | |
| **EU27** | 17 | 17 | 39 | 39 | 8 | 7 | 2 | 2 | 9 | 10 | 24 | 25 |
| **EU15** | 18 | 18 | 40 | 41 | 8 | 6 | 2 | 2 | 8 | 8 | 24 | 24 |
| **NM10** | 15 | 15 | 20 | 16 | 15 | 9 | 5 | 3 | 15 | 26 | 30 | 31 |
| **BE** | 11 | 18 | 36 | 24 | 8 | 11 | 8 | 10 | 25 | 15 | 11 | 22 |
| **BG** | 25 | 25 | 22 | 19 | 17 | 16 | 20 | 13 | 6 | 6 | 11 | 21 |
| **CZ** | 22 | 23 | 23 | 22 | 10 | 8 | 5 | 3 | 5 | 5 | 36 | 32 |
| **DK** | 52 | 41 | 17 | 26 | 7 | 7 | 1 | 0 | 9 | 9 | 14 | 18 |
| **DE** | 13 | 13 | 55 | 57 | 6 | 4 | 1 | 1 | 8 | 7 | 17 | 19 |
| **ES** | 22 | 22 | 18 | 20 | 9 | 10 | 5 | 4 | 10 | 10 | 37 | 35 |
| **FR** | 16 | 16 | 45 | 45 | 11 | 8 | 3 | 3 | 6 | 6 | 19 | 21 |
| **IT** | 15 | 16 | 24 | 23 | 5 | 7 | 2 | 1 | 10 | 10 | 44 | 43 |
| **HU** | 7 | 5 | 16 | 7 | 10 | 3 | 2 | 3 | 38 | 60 | 26 | 23 |
| **NL** | 21 | 20 | 23 | 25 | 19 | 15 | 2 | 2 | 11 | 11 | 26 | 26 |
| **AT** | 25 | 28 | 25 | 30 | 8 | 5 | 3 | 2 | 8 | 7 | 30 | 28 |
| **PL** | 7 | 12 | 19 | 20 | 21 | 15 | 5 | 4 | 12 | 19 | 24 | 30 |
| **RO** | 20 | 14 | 14 | 17 | 11 | 8 | 4 | 3 | 22 | 7 | 29 | 50 |
| **SI** | 37 | 32 | 17 | 14 | 1 | 0 | 6 | 5 | 5 | 2 | 34 | 46 |
| **SK** | 22 | 21 | 10 | 7 | 28 | 25 | 1 | 0 | 7 | 12 | 32 | 34 |
| **FI** | 47 | 58 | 19 | 15 | 13 | 8 | 0 | 0 | 8 | 6 | 14 | 13 |
| **SE** | 28 | 23 | 31 | 35 | 16 | 17 | : | : | 10 | 11 | 10 | 14 |
| **UK** | 17 | 20 | 34 | 31 | 10 | 6 | 2 | 3 | 10 | 13 | 27 | 27 |
| **Employment** | | | | | | | | | | | | |
| **EU27** | 18 | 17 | 33 | 33 | 9 | 8 | 3 | 2 | 10 | 10 | 28 | 30 |
| **EU15** | 17 | 17 | 37 | 38 | 8 | 7 | 3 | 2 | 9 | 9 | 26 | 26 |
| **NM10** | 21 | 20 | 20 | 20 | 12 | 12 | 3 | 3 | 15 | 13 | 28 | 33 |
| **BE** | 14 | 16 | 35 | 28 | 7 | 11 | 6 | 7 | 24 | 16 | 14 | 22 |
| **BG** | 30 | 28 | 29 | 22 | 7 | 7 | 10 | 10 | 8 | 9 | 16 | 25 |
| **CZ** | 28 | 23 | 23 | 23 | 8 | 11 | 3 | 3 | 5 | 6 | 33 | 36 |
| **DK** | 48 | 50 | 16 | 18 | 5 | 5 | 2 | 0 | 11 | 10 | 17 | 17 |
| **DE** | 13 | 13 | 56 | 55 | 5 | 4 | 2 | 1 | 8 | 7 | 17 | 19 |
| **ES** | 20 | 24 | 15 | 17 | 9 | 9 | 3 | 4 | 14 | 14 | 39 | 33 |
| **FR** | 17 | 17 | 42 | 42 | 10 | 9 | 3 | 4 | 7 | 7 | 21 | 21 |
| **IT** | 16 | 15 | 19 | 20 | 7 | 7 | 2 | 2 | 9 | 10 | 46 | 47 |
| **HU** | 10 | 11 | 13 | 11 | 10 | 6 | 2 | 3 | 28 | 29 | 36 | 40 |
| **NL** | 21 | 21 | 27 | 22 | 15 | 15 | 2 | 1 | 14 | 14 | 20 | 26 |
| **AT** | 27 | 26 | 30 | 30 | 9 | 5 | 2 | 2 | 10 | 10 | 22 | 27 |
| **PL** | 12 | 15 | 23 | 22 | 18 | 11 | 4 | 3 | 18 | 15 | 29 | 34 |
| **RO** | 25 | 13 | 15 | 13 | 6 | 5 | 2 | 1 | 13 | 4 | 39 | 64 |
| **SI** | 30 | 28 | 19 | 18 | 2 | 1 | 6 | 6 | 5 | 4 | 38 | 43 |
| **SK** | 18 | 14 | 11 | 7 | 28 | 29 | 0 | 0 | 8 | 9 | 34 | 41 |
| **FI** | 38 | 52 | 21 | 19 | 13 | 10 | 0 | 0 | 9 | 6 | 19 | 13 |
| **SE** | 23 | 23 | 21 | 32 | 29 | 16 | : | : | 7 | 12 | 10 | 14 |
| **UK** | 19 | 18 | 30 | 30 | 9 | 7 | 3 | 3 | 12 | 13 | 26 | 29 |

*Source: Eurostat, Structural Business Statistics*

As in the case of mechanical engineering, there is little sign of any tendency for the composition of the sector to change over recent years, at least at this level of disaggregation and at the EU level as a whole. The main change evident is the increase in the share of value-added in the new Member States produced by the manufacture of lighting and lamps, which, however, is not evident in the share of employment, which indeed has declined rather than increased over the past few years.

This increase is a reflection of a shift in production from EU15 countries to the new Member States, almost a quarter of the value-added produced by the lighting industry in the EU being generated in the new Member States in 2005 and almost a third of the jobs being located there (Table 7). A relative shift, less marked but still significant, is also apparent in the manufacture of electric motors and generators and other electrical equipment, in the latter especially in terms of employment, which was also the case for insulated wire and cables.

**Table 7 Division of value-added and employment in NACE 31 between EU Member States**

*% Total value-added/employment in the EU*

| | Electrical equipment and apparatus (NACE 31) | | Electric motors, generators (311) | | Electricity distibution +control apparatus (312) | | Insulated wire+cable (313) | | Accumulators , batteries (314) | | Lighting +lamps (315) | | Other electrical equipment (316) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| **Value-added (EUR)** | | | | | | | | | | | | | | |
| **EU27** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **EU15** | 94 | 91 | 95 | 92 | 97 | 97 | 89 | 88 | 88 | 87 | 90 | 77 | 92 | 89 |
| **DE** | 39 | 40 | 29 | 29 | 55 | 58 | 26 | 23 | 21 | 24 | 32 | 27 | 27 | 30 |
| **IT** | 12 | 12 | 11 | 11 | 14 | 13 | 16 | 14 | 16 | 15 | 8 | 7 | 20 | 20 |
| **Oth EU15** | 43 | 40 | 55 | 52 | 28 | 26 | 46 | 50 | 51 | 48 | 50 | 42 | 45 | 39 |
| **NM10** | 6 | 9 | 5 | 8 | 3 | 3 | 11 | 12 | 12 | 13 | 10 | 23 | 8 | 11 |
| **Employment** | | | | | | | | | | | | | | |
| **EU27** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **EU15** | 77 | 73 | 74 | 73 | 87 | 85 | 69 | 64 | 73 | 70 | 70 | 69 | 73 | 63 |
| **DE** | 30 | 29 | 22 | 23 | 50 | 49 | 17 | 16 | 17 | 17 | 22 | 21 | 18 | 18 |
| **IT** | 10 | 9 | 9 | 9 | 12 | 12 | 11 | 11 | 11 | 16 | 6 | 7 | 20 | 18 |
| **Oth EU15** | 38 | 34 | 43 | 41 | 25 | 24 | 41 | 37 | 45 | 37 | 41 | 41 | 36 | 27 |
| **NM10** | 23 | 27 | 26 | 27 | 13 | 15 | 31 | 36 | 27 | 30 | 30 | 31 | 27 | 37 |

*Source: Structural Business Statistics*

It is equally apparent that the large share of Germany in the electrical engineering is mainly due to its dominance in the manufacture of electricity distribution apparatus and control systems, in which it accounted for 58% of total value-added produced in the EU, and for around half of all jobs.

## Size distribution of enterprises

The division of value-added and employment between enterprises of different size provides an indication of the relative importance of large firms as compared with SMEs in different parts of the sector, but the production characteristics of the various sub-sectors.

Unfortunately, no recent data are available to examine this aspect of the sector in any detail across the EU as a whole. The Structural Business Statistics, compiled by Eurostat, include data by size of enterprise, but the maximum size distinguished in more recent years is 250 or more persons employed, with large enterprises being conventionally defined in the EU as falling within this category. Enterprises towards the bottom end of this category, however, are relatively small in global terms.

The most recent data which subdivides this size category are for 2001. Although this is now some time ago, the evidence suggests that the size distribution of enterprises tends not to change rapidly over time. This is confirmed if the more aggregated data for the division of employment between firms of different size in 2005 are compared with similar data for 2001 (see Box). The 2001 data examined below, therefore, should provide a reasonable indication of the relative importance of firms of different size at present.

**Box: Comparison of size distribution of firms in the electro-mechanical engineering sector in 2001 and 2005**

*% employed in each sector*

| | EU25 | | DE | | IT | | CZ | | HU | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| **NACE 29** | | | | | | | | | | |
| <50 | 30 | 28 | 18 | 17 | 44 | 45 | 22 | 21 | 32 | 33 |
| 50-249 | 29 | 28 | 28 | 27 | 27 | 27 | 35 | 33 | 31 | 30 |
| 250+ | 42 | 44 | 54 | 57 | 28 | 28 | 43 | 46 | 37 | 36 |
| **NACE 31** | | | | | | | | | | |
| <50 | 22 | 21 | 12 | 10 | 53 | 52 | 25 | 29 | 10 | 9 |
| 50-249 | 22 | 21 | 19 | 19 | 24 | 20 | 20 | 22 | 15 | 12 |
| 250+ | 56 | 58 | 69 | 71 | 23 | 28 | 54 | 49 | 76 | 79 |

*Source: Eurostat, Structural Business Statistics*

The comparison indicates that the share of employment in the two parts of the sector accounted for by small, medium and large firms, as conventionally defined in the EU, was much the same in 2005 as in 2001. Some tendency is evident for the share of large enterprises to increase in both parts and the share of SMEs to decline but at a relatively slow rate.

## Machinery and equipment sector

In the machinery and equipment sector, large firms (as conventionally defined) accounted for almost half of value-added across the EU, and for 44% of employment in 2001, while firms with 1,000 or more persons employed were responsible for 24% of value-added and 20% of employment (Table 8).

These figures, however, varied between Member States, being higher in Germany, where firms of 1,000 or more workers accounted for 35% of value-added in the sector and 30% of employment, and lower in Italy as well as the Czech Republic and Hungary, where they accounted for 12-16% of value-added and a slightly smaller share of employment. (The latter two countries are intended to be broadly representative of the size distribution of enterprises in the new Member States, though in Romania, in particular, enterprises tend to be larger than elsewhere as vestiges of the former regime.) In Italy, as in most sectors, small firms (i.e. those with less than 50 people employed) are more important than elsewhere, generating 38% of the value-added produced by the sector and provided 45% of the jobs.

The division of value-added and employment between different sized firms also varies between sub-sectors. Large enterprises are particularly important in the manufacture of engines and turbines (i.e. in NACE 29.1) and, even more so, in the production of domestic appliances than in other parts of the sector. In the former, firms with 1,000 people or more employed accounted for 35% of value-added and 29% of employment, while SMEs (as conventionally defined) accounted for around the same share of value-added but a much larger share of employment (42%).

In Germany, which is responsible for 40% of the total net output produced in the EU, firms with 1000 or more employed accounted for 52% of value-added and 48% of employment. Since firms with 250-999 persons also accounted for a significant share of output, SMEs – i.e. firms with less than 250 people employed – were responsible for only 22% of value-added in Germany and for 25% of employment.

Firms with 1,000 or more were much less important, however, in Italy as well as in both the Czech Republic and Hungary in which producers, like in the other new Member States, were responsible for only a very small share of output. Nevertheless, in both these countries, large firms as conventionally defined still accounted for almost half of value-added in Hungary and 60% in the Czech Republic.

In domestic appliances, large firms of 1,000 or more were responsible for 53% of value-added in the EU as a whole and for 74% in Germany, while they also accounted for a relatively large share of output in both Italy and Hungary (there are no data for the Czech Republic) which equally had a relatively large share of production, at least a compared with other parts of the sector. In this industry, by contrast, SMEs were responsible for under a quarter of value-added in the EU as a whole and for only just over a quarter in Italy.

In other sub-sectors, apart from weapons and ammunition, firms with 1,000 or more employed are less important. This is especially the case in the manufacture of machine tools, though they are more important in both Germany and the Czech Republic than elsewhere, both of which accounted for relatively large shares of the value-added produced in the EU. In this industry, SMEs were responsible for almost 60% of value-added in the EU as a whole and for over 60% of employment. This was also the case in the other three sub-sectors – in the manufacture of both general-purpose and special-purpose machinery and of agricultural machinery.

## Electrical equipment sector

Large firms are more important in the electrical equipment sector, those employing 250 or more people accounting for 64% of value-added and 58% of employment across the EU in 2001, while those employing 1,000 or more were responsible for 37% of value-added and 33% of employment (Table 9).

In Germany, firms in the latter size category accounted for just over half of value-added and almost half of employment, while in contrast to mechanical engineering, they also accounted for a similarly large share of output in Hungary, which, as noted above, is a more important producer in this part of the sector. By the same token, in Italy, where this part of the sector is less important than mechanical engineering, large firms with 1,000 or more workers were responsible for 12% of value-added and SMEs accounted for around two-thirds of value-added and for over 70% of employment.

Large enterprises are particularly important in the manufacture of apparatus for electricity distribution, those of 1,000 or more accounting in 2001 for 52% of value-added in the EU and 68% in Germany, which in turn was responsible for well over half of the total net output produced by the industry in the EU, as noted above.

**Table 8 Division of value-added and employment in the manufacture of Machinery and equipment (NACE 29) by employment size of enterprise, 2001**

*% value-added/employed in each sector*

| | Value-added | | | | | Employment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EU25 | DE | IT | CZ | HU | EU25 | DE | IT | CZ | HU |
| **NACE 29** | | | | | | | | | | |
| <50 | 23 | 13 | 38 | 19 | 29 | 28 | 17 | 45 | 21 | 33 |
| 50-249 | 27 | 24 | 31 | 32 | 32 | 28 | 27 | 27 | 33 | 30 |
| 250-999 | 25 | 28 | 17 | 33 | 26 | 24 | 27 | 15 | 30 | 25 |
| 1000+ | 24 | 35 | 15 | 16 | 12 | 20 | 30 | 13 | 16 | 11 |
| **Engines, turbines (29.1)** | | | | | | | | | | |
| <50 | 13 | 4 | 20 | 8 | 13 | 16 | 4 | 26 | 12 | 11 |
| 50-249 | 24 | 18 | 34 | 31 | 39 | 26 | 21 | 32 | 24 | 35 |
| 250-999 | 28 | 27 | 24 | 51 | 40 | 29 | 27 | 22 | 47 | 41 |
| 1000+ | 35 | 52 | 22 | 10 | 7 | 29 | 48 | 20 | 17 | 13 |
| **General purpose machinery (29.2)** | | | | | | | | | | |
| <50 | 29 | 14 | 51 | 38 | 31 | 35 | 19 | 58 | 40 | 43 |
| 50-249 | 29 | 27 | 29 | 33 | 34 | 30 | 29 | 25 | 34 | 29 |
| 250-999 | 23 | 26 | 14 | 28 | 20 | 21 | 25 | 12 | 26 | 16 |
| 1000+ | 19 | 33 | 6 | 0 | 15 | 14 | 27 | 5 | 0 | 12 |
| **Agricultural machinery (29.3)** | | | | | | | | | | |
| <50 | 37 | 37 | 46 | 8 | 10 | 45 | 45 | 58 | 27 | 9 |
| 50-249 | 22 | 10 | 15 | 42 | 31 | 25 | 11 | 16 | 20 | 36 |
| 250-999 | 22 | 16 | 21 | 51 | 35 | 18 | 15 | 15 | 53 | 27 |
| 1000+ | 19 | 36 | 18 | 0 | 24 | 12 | 30 | 11 | 0 | 28 |
| **Machine tools (29.4)** | | | | | | | | | | |
| <50 | 25 | 6 | 36 | 2 | 18 | 29 | 18 | 45 | 11 | 27 |
| 50-249 | 33 | 29 | 25 | 31 | 7 | 33 | 32 | 22 | 22 | 7 |
| 250-999 | 29 | 35 | 39 | 24 | 75 | 27 | 33 | 33 | 27 | 67 |
| 1000+ | 14 | 30 | | 42 | | 11 | 17 | | 40 | |
| **Special purpose machinery (29.5)** | | | | | | | | | | |
| <50 | 28 | 16 | 43 | 16 | 32 | 33 | 20 | 50 | 18 | 36 |
| 50-249 | 31 | 29 | 36 | 34 | 36 | 31 | 30 | 30 | 33 | 34 |
| 250-999 | 24 | 29 | 14 | 33 | 32 | 23 | 27 | 12 | 32 | 30 |
| 1000+ | 17 | 26 | 8 | 17 | 0 | 14 | 22 | 8 | 16 | 0 |
| **Weapons (29.6)** | | | | | | | | | | |
| <50 | 6 | | 14 | | | 6 | | 24 | 6 | |
| 50-249 | 15 | | 31 | | | 14 | | 16 | 11 | |
| 250-999 | 39 | | 54 | | | 34 | | 60 | 83 | |
| 1000+ | 40 | | | | | 46 | | | | |
| **Domestic appliances (29.7)** | | | | | | | | | | |
| <50 | 7 | 3 | 9 | | 3 | 10 | 4 | 12 | 22 | 3 |
| 50-249 | 16 | 3 | 17 | | 19 | 17 | 4 | 17 | 19 | 21 |
| 250-999 | 23 | 20 | 24 | | 31 | 24 | 23 | 22 | 58 | 34 |
| 1000+ | 53 | 74 | 50 | | 48 | 50 | 70 | 50 | | 42 |

*Note: A blank denotes no data available. When there is a blank for '1000+' and data for '250-999', this denotes that the data do not enable the figures for enterprises with 250 or more employees to be subdivided. In these cases, part of the value-added and employment is in enterprises with 1000 or more persons employed. Note that some of the figures involve estimation.*

*Source: Eurostat, Structural Business Statistics*

Firms of this size are less important across the EU in the manufacture of lighting equipment and lamps. This is not the case, however, in Hungary which accounts for a significant share of total production in the Union and where enterprises of 1,000 people or more were responsible for over three-quarters of the value-added generated by the industry in the country in 2001.

Lighting equipment and lamps is the only sub-sector in electrical engineering in which SMEs accounted for over half of value-added in the EU as a whole as well as in most countries, Italy apart. In the electrical equipment sector as a whole, they were responsible for just 36% of the value-added produced in the EU and in both equipment for electricity distribution and accumulators and batteries for only around a quarter. Although SMEs accounted for a slightly larger share of employment than of value-added, they were responsible for over half of employment in only two-sub-sectors – lighting equipment and lamps and electrical machinery and generators – which between accounted for only just over a quarter of the total number employed in the sector.

**Table 9 Division of value-added and employment in the manufacture of Electrical equipment and apparatus (NACE 31) by employment size of enterprise, 2001**

*% value-added/employed in each sector*

| | Value-added | | | | | Employment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EU25 | DE | IT | CZ | HU | EU25 | DE | IT | CZ | HU |
| **NACE 31** | | | | | | | | | | |
| <50 | 16 | 8 | 42 | 14 | 6 | 21 | 10 | 52 | 29 | 9 |
| 50-249 | 20 | 16 | 24 | 22 | 12 | 21 | 19 | 20 | 22 | 12 |
| 250-999 | 27 | 25 | 22 | 34 | 33 | 25 | 23 | 16 | 29 | 31 |
| 1000+ | 37 | 51 | 12 | 30 | 49 | 33 | 48 | 12 | 20 | 48 |
| **Electric motors (31.1)** | | | | | | | | | | |
| <50 | 19 | 24 | 45 | 32 | 18 | 27 | 26 | 47 | 57 | 26 |
| 50-249 | 23 | 17 | 40 | 6 | 37 | 26 | 20 | 30 | 14 | 31 |
| 250-999 | 30 | 35 | 15 | 62 | 46 | 28 | 36 | 13 | 29 | 43 |
| 1000+ | 28 | 25 | 0 | 0 | 0 | 19 | 18 | 11 | 0 | 0 |
| **Electricity distribution apparatus (31.2)** | | | | | | | | | | |
| <50 | 9 | 5 | 24 | 14 | 7 | 13 | 7 | 38 | 27 | 12 |
| 50-249 | 16 | 4 | 18 | 30 | 18 | 19 | 4 | 19 | 29 | 22 |
| 250-999 | 22 | 24 | 32 | 56 | 48 | 23 | 24 | 24 | 44 | 49 |
| 1000+ | 52 | 68 | 27 | 0 | | 45 | 64 | 19 | 0 | |
| **Insulated wire+cables (31.3)** | | | | | | | | | | |
| <50 | 11 | 11 | 29 | 2 | 5 | 12 | 12 | 28 | 8 | 8 |
| 50-249 | 24 | 12 | 50 | 16 | 27 | 24 | 16 | 33 | 17 | 17 |
| 250-999 | 37 | 38 | 21 | 82 | 68 | 31 | 34 | 39 | 75 | 75 |
| 1000+ | 28 | 39 | | 0 | | 33 | 38 | | 0 | |
| **Accumulators, batteries (31.4)** | | | | | | | | | | |
| <50 | 6 | | 9 | | | 8 | | 17 | | |
| 50-249 | 17 | | 20 | | | 16 | | 22 | | |
| 250-999 | 39 | | 71 | | | 40 | | 62 | | |
| 1000+ | 38 | | | | | 37 | | | | |
| **Lighting+lamps (31.5)** | | | | | | | | | | |
| <50 | 27 | 27 | 52 | 14 | 2 | 31 | 31 | 63 | 21 | 4 |
| 50-249 | 24 | 15 | 20 | 40 | 5 | 23 | 16 | 16 | 8 | 5 |
| 250-999 | 23 | 24 | 28 | 46 | 17 | 21 | 23 | 20 | 71 | 20 |
| 1000+ | 26 | 35 | | | 76 | 24 | 30 | | | 70 |
| **Other electrical equipment (31.6)** | | | | | | | | | | |
| <50 | 24 | | 53 | 8 | 9 | 27 | | 62 | 15 | 9 |
| 50-249 | 20 | | 20 | 20 | 4 | 18 | | 16 | 24 | 5 |
| 250-999 | 29 | | 15 | 24 | 39 | 25 | | 11 | 28 | 29 |
| 1000+ | 27 | | 12 | 48 | 48 | 30 | | 11 | 33 | 57 |

*Note: A blank denotes no data available. When there is a blank for '1000+' and data for '250-999', this denotes that the data do not enable the figures for enterprises with 250 or more employees to be subdivided. In these cases, part of the value-added and employment is in enterprises with 1000 or more persons employed. Note that some of the figures involve estimation.*

*Source: Eurostat, Structural Business Statistics*

### The electro-mechanical sector

In general, across the electro-mechanical sector as a whole, there is a positive relationship between the relative importance of large firms and the performance of sub-sectors in particular countries. Moreover, there is some evidence of large enterprises becoming more important in both main parts of the sector across the EU as a whole, as well as in most countries.

## Other structural aspects of the sector

Value-chains in the sectors are varied. Closeness to end-users is particularly important for some parts of mechanical engineering (such as component suppliers for automobiles and white goods) and is a major factor behind many plant relocations from EU15 to EU12, or to Asia. At the 'heavy' end of electrical engineering sector there have been fewer cases of relocations, although this is changing with more European companies establishing facilities in Asia.

Brand image and intellectual capital are important competitive elements for established companies, and while much imitation is legitimate – best practice, training, technology - theft is a significant concern for European manufacturers, creating some doubts with respect to outsourcing.

Research and development strategies are difficult to determine in such a diverse industry, with significant developments mainly taking place in large companies, often linked to the needs of end-users. Electrical engineering may have become complacent given protected national markets, notably regarding energy production, although this is liable to change with market liberalisation.

Mechanical engineering is more varied than electrical engineering in terms of end-user markets, size of firm, and importance of R&D, with leading-edge innovative companies working next door to traditional firms serving local or niche markets. Many SMEs are also primarily suppliers to larger companies in the value chain.

Raw materials are of particular importance for these industries since companies increasingly provide solutions to problems (in a range of alternative forms and materials). Energy is, likewise, central to concerns and costs since the industry is not only a major user of energy, but also a major user of energy-intensive inputs (notably materials).

## Regional location of employment

The electro-mechanical sector is not only more important in some countries in the EU than in others, it is also concentrated in relatively few regions within countries. Moreover, regions which have a large share of employment in machinery and equipment also have a large share in electrical equipment. At the same time, there are some significant differences in regional location between the two parts of the sector as a whole.

### Machinery and equipment

The machinery and equipment part of the sector is very much concentrated in the south-western part of Germany – in Baden-Wurttemberg, around Stuttgart and Karlsruhe (where it accounts for around 6% or more of total employment) and in Baveria, especially in Mitttel- and Unter-franken (accounting for 7% of employment in the latter) – and in the northern part of Italy (in Lombardia, Veneto, Friuli-Venezia Giulia, Emilia-Romagna and further south in Marche, in each of which it is provides around 5% of jobs or more).

It is also relatively important in Jihovychod and Stredni Morava in the south-eastern part of the Czech Republic, where it is responsible for 4-5% of total employment as well as in the north-central and south-central regions of Bulgaria. Elsewhere, there are other regions where the sector accounts for around 4% of employment or slightly more: in Alsace in France, Pais Vasco in Spain, Lincolnshire in the UK, and in the south of Sweden and Finland.

See Map 1 for further details regarding the above.

## Electrical equipment

The electrical equipment sector is located in some of the same regions as the mechanical equipment sector but, in general, employment is much more concentrated in regions in the new Member States than in the latter case. Just as in the case of machinery and equipment, the sector, therefore, accounts for a relatively large share of employment in Oberpfalz and Mittelfranken in the southern part of Germany (around 2.5% in both cases) and Arnsberg in the west, as well as in Jihovychod and Stredni Morava in the south-eastern part of the Czech Republic.

However, it also accounts for a similarly large share in Jihozapad in the south-western part of the Czech Republic, in western regions of Hungary, Zapadne Slovensko in the west of Slovakia (where its share is almost 4%) and Vest in the western part of Romania (where it is almost 6%, the largest in the EU), as well as Lubuskie in the west of Poland. The sector is slightly less important in Slovenia and the south-eastern region of Bulgaria , though it still accounted for around 2% of total employment in 2006.

On the other hand, there is no region in France, Italy, Spain and the UK where the sector accounted for more than 1.5% of employment in 2006.

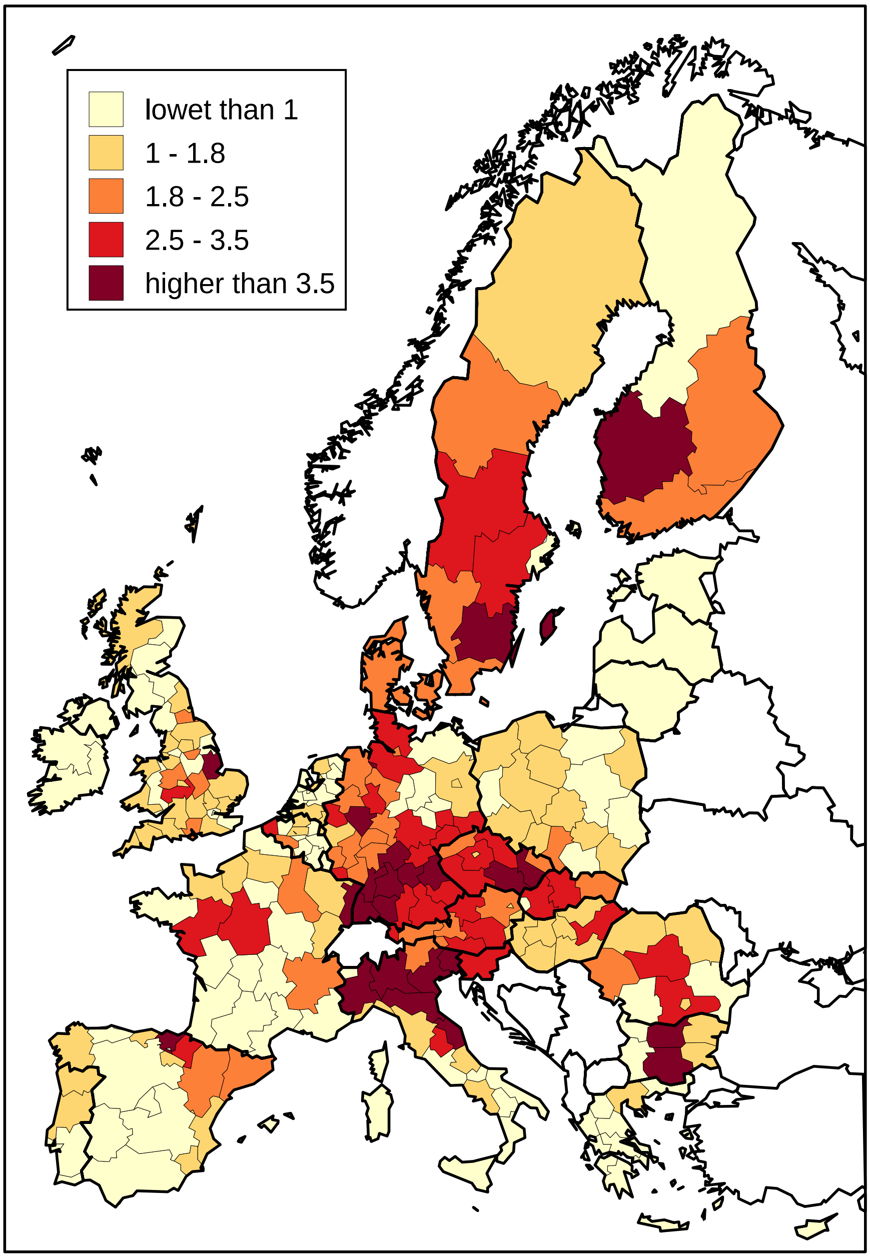
See Map 2 for further details regarding the above

## The electro-mechanical sector as a whole

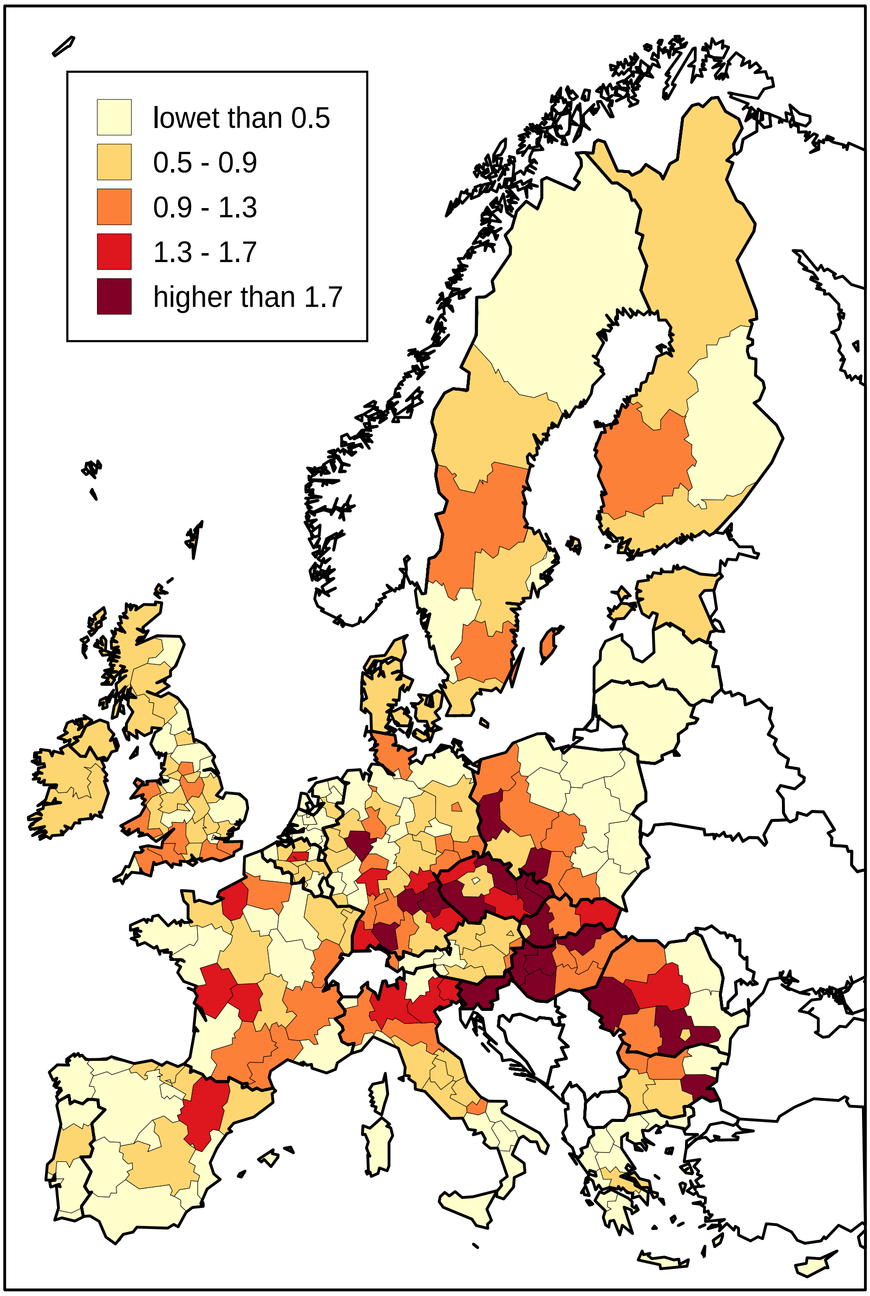
Taking the two parts of the sector together, electro-mechanical engineering accounted for over 7% of total employment in 6 NUTS 2 regions, three of them in Germany (Stuttgart, Tübingen and Unterfranken), one in Italy (Emilia Romagna), one in the Czech Republic (Stredni Morava) and one in Romania (Vest), while it was only marginally below 7% in Zapadne Slovensko in Slovakia.

The regions in which the two sectors were most important in terms of employment in 2006 were also, in most cases, the regions where it was most important in earlier years, though there were significant increases in the employment share over the period 1999-2006 in the Hungarian regions in particular.

**Map 1 Employment in the machinery and equipment sector (NACE 29) by region (as % of total regional employment) 2006**



**Map 2 Employment in the electrical equipment and apparatus sector (NACE 31) by region (as % of total regional employment) 2006**




## Trade in electro-mechanical products

The products of the electro-mechanical sector contribute significantly to EU exports and to the overall surplus on trade with the rest of the world. As a result they play a major role in funding imports, and in supporting the growth of the EU economy.

In 2007 electro-mechanical products made up some 21% of the total exports of goods of the EU to third countries in value terms, with machinery and equipment accounting for just over 16% of the total, and electrical equipment and apparatus for just under 5% of the total

(Table 10). In both cases, this was an increase on levels achieved 8 years earlier, and even more than 4 years earlier (in 2003).

**Table 10 Exports of Electro-mechanical engineering products relative to total exports**

*% Total exports*

| | Electro-mechanical (NACE 29+31) | | | Machinery+equipment (NACE 29) | | | Elecrical equipment (NACE 31) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1999 | 2003 | 2007 | 1999 | 2003 | 2007 | 1999 | 2003 | 2007 |
| **EU27*** | **20.0** | **19.2** | **21.0** | **15.4** | **15.0** | **16.2** | **4.5** | **4.2** | **4.8** |
| **BE** | 9.2 | 8.2 | 8.3 | 6.7 | 5.9 | 6.2 | 2.5 | 2.3 | 2.1 |
| **BG** | 8.9 | 9.9 | 11.2 | 6.4 | 6.0 | 7.2 | 2.5 | 4.0 | 3.9 |
| **CZ** | 22.2 | 22.2 | 21.9 | 11.6 | 12.4 | 12.7 | 10.6 | 9.8 | 9.1 |
| **DK** | 16.2 | 16.6 | 19.2 | 11.7 | 11.5 | 12.6 | 4.6 | 5.1 | 6.6 |
| **DE** | 21.4 | 20.7 | 20.8 | 16.0 | 15.4 | 15.4 | 5.4 | 5.3 | 5.4 |
| **ES** | 10.7 | 10.0 | 11.5 | 7.0 | 6.8 | 7.2 | 3.6 | 3.3 | 4.3 |
| **FR** | 15.0 | 13.6 | 14.6 | 10.8 | 9.5 | 10.2 | 4.2 | 4.1 | 4.4 |
| **IT** | 23.2 | 23.0 | 24.6 | 20.1 | 20.0 | 21.0 | 3.0 | 3.0 | 3.6 |
| **HU** | 14.9 | 17.7 | 16.0 | 5.3 | 7.5 | 7.7 | 9.6 | 10.3 | 8.2 |
| **NL** | 8.0 | 7.9 | 10.0 | 5.6 | 5.7 | 7.9 | 2.4 | 2.3 | 2.1 |
| **AT** | 20.4 | 19.6 | 20.9 | 14.3 | 13.4 | 15.1 | 6.1 | 6.2 | 5.7 |
| **PL** | 12.2 | 13.0 | 15.7 | 6.7 | 7.1 | 9.5 | 5.5 | 5.9 | 6.2 |
| **RO** | 9.1 | 12.2 | 18.4 | 5.4 | 5.9 | 8.9 | 3.7 | 6.3 | 9.5 |
| **SI** | 20.3 | 21.5 | 20.7 | 13.5 | 14.1 | 14.8 | 6.8 | 7.4 | 5.9 |
| **SK** | 14.6 | 13.5 | 13.8 | 8.6 | 7.6 | 8.0 | 5.9 | 5.8 | 5.8 |
| **FI** | 16.0 | 15.8 | 19.0 | 10.4 | 11.1 | 14.0 | 5.6 | 4.7 | 5.0 |
| **SE** | 17.4 | 17.4 | 18.8 | 13.1 | 13.4 | 15.0 | 4.4 | 4.0 | 3.8 |
| **UK** | 17.9 | 16.4 | 16.2 | 13.2 | 12.4 | 12.6 | 4.7 | 4.1 | 3.6 |

** EU27 figures relate to the proportion of total exports of goods to other countries*

*Source: Eurostat, External trade statistics*

## Balance of trade

The EU has a surplus on trade with the rest of the world on both machinery and equipment and electrical equipment and apparatus. The surplus is particularly large on the products of the mechanical equipment sector, amounting to around 37% of the combined value of exports and imports in 2007 (Table 11).

The contribution of products manufactured by the sector to total exports is particular important in Germany, Italy and Austria, among EU15 countries – in line with the relatively large share of the sector in overall output – and in the Czech Republic and Slovenia among the new Member States, in each case accounting for over 20% of the total in 2007. (These figures, it should be noted, relate to total exports, including to other EU countries as well as to countries outside the EU.)

In each case, the larger part of the contribution came from machinery and equipment, which in Italy alone accounted for 21% of total exports of goods. Nevertheless, the electrical equipment part of the sector contributed substantially to exports in a number of the new Member States, most especially in the Czech Republic and Romania, where it accounted for over 9% of visible exports, and to a slightly lesser extent in Hungary, making up 8% of the total.

Between 1999 and 2007, the contribution of machinery and equipment to exports of goods increased in most Member States, most especially in Finland, Poland and Romania (by around 3 percentage points or more in each case).

By contrast, the contribution of electrical equipment and apparatus declined in most countries, even though there was an increase in aggregate in their contribution to exports to countries outside the EU. The main exceptions were Denmark and Romania, especially the latter, in which the share of such products in visible exports increased by almost 6 percentage points over this period.

**Table 11 Trade balance on electro-mechanical products relative to total trade flows**

*Trade balance as % exports+imports*

| | Electro-mechanical (NACE 29+31) | | | Machinery+equipment (NACE 29) | | | Elecrical equipment (NACE 31) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1999 | 2003 | 2007 | 1999 | 2003 | 2007 | 1999 | 2003 | 2007 |
| **EU27*** | **19.5** | **25.6** | **30.3** | **27.3** | **34.2** | **36.7** | **-1.1** | **2.3** | **12.5** |
| BE | -5.5 | -1.6 | -3.6 | -4.8 | -0.9 | -3.2 | -7.4 | -3.3 | -4.8 |
| BG | -29.6 | -32.6 | -33.6 | -33.4 | -40.7 | -39.3 | -17.4 | -15.2 | -19.6 |
| CZ | -1.3 | 0.8 | 10.9 | -7.4 | -1.5 | 12.1 | 6.5 | 4.0 | 9.3 |
| DK | 10.7 | 18.8 | 16.5 | 12.7 | 18.5 | 14.8 | 5.9 | 19.5 | 19.9 |
| DE | 29.0 | 32.2 | 36.4 | 36.6 | 41.0 | 43.4 | 10.9 | 11.9 | 19.8 |
| ES | -23.5 | -25.5 | -22.0 | -27.9 | -27.6 | -27.6 | -13.2 | -20.8 | -10.4 |
| FR | 0.8 | 1.5 | 1.8 | -0.2 | -0.2 | 0.1 | 3.7 | 5.7 | 5.8 |
| IT | 35.5 | 36.8 | 39.6 | 43.5 | 44.9 | 46.8 | -1.2 | -0.9 | 8.6 |
| HU | -25.6 | -19.9 | -10.7 | -42.5 | -28.3 | -4.5 | -11.2 | -12.3 | -15.9 |
| NL | -7.4 | -2.7 | 9.2 | -3.6 | 2.4 | 15.9 | -15.1 | -13.6 | -10.0 |
| AT | 9.9 | 12.3 | 18.2 | 13.3 | 15.6 | 21.3 | 2.5 | 5.8 | 10.9 |
| PL | -41.4 | -22.9 | -6.3 | -52.1 | -34.4 | -13.2 | -19.2 | -2.2 | 6.6 |
| RO | -37.6 | -29.4 | -22.6 | -42.4 | -41.7 | -36.2 | -28.8 | -12.4 | -3.3 |
| SI | 4.6 | 10.4 | 19.9 | 4.0 | 10.0 | 22.1 | 5.6 | 11.2 | 14.6 |
| SK | -14.3 | -12.5 | -5.6 | -17.0 | -12.8 | -3.0 | -10.2 | -12.1 | -8.9 |
| FI | 10.7 | 16.9 | 28.2 | 18.1 | 25.5 | 35.9 | -1.1 | 0.6 | 10.6 |
| SE | 12.2 | 20.0 | 19.5 | 21.1 | 25.8 | 25.9 | -8.0 | 3.8 | -0.3 |
| UK | 1.6 | 2.3 | -3.0 | 6.5 | 5.2 | 0.4 | -9.9 | -5.5 | -13.2 |

** EU27 figures relate to net balance as % exports and imports to and from third countries*

*Source: Eurostat, External trade statistics*

Within the EU, the two countries where the sector is most important, Germany and Italy, have the largest surpluses on such trade (of around 45% of exports and imports taken together in 2007), while the surplus is also significant in Finland (over 35% of exports plus imports), Sweden (over 25%), Austria and Slovenia (over 20% in both cases). Only the Czech Republic and Slovenia, among the new Member States, have a surplus on trade in machinery and equipment, however

Over the period 1999-2007, the EU surplus on machinery and equipment increased by over 9% of the combined value of exports and imports, and the surplus increased further (or the deficit declined) in most countries. The improvement was especially marked in the Czech Republic, Hungary and Poland.

In the electrical equipment sector, the EU’s surplus with the rest of the world amounted to just over 12% of the combined value of exports and imports in 2007, with Denmark and Germany having particularly large surpluses of just under 20% of exports plus imports. The Czech Republic and Slovenia also had significant surpluses on trade in this part of the sector as well as on the machinery and equipment sector, along with Poland as well as Italy, Austria and Finland.

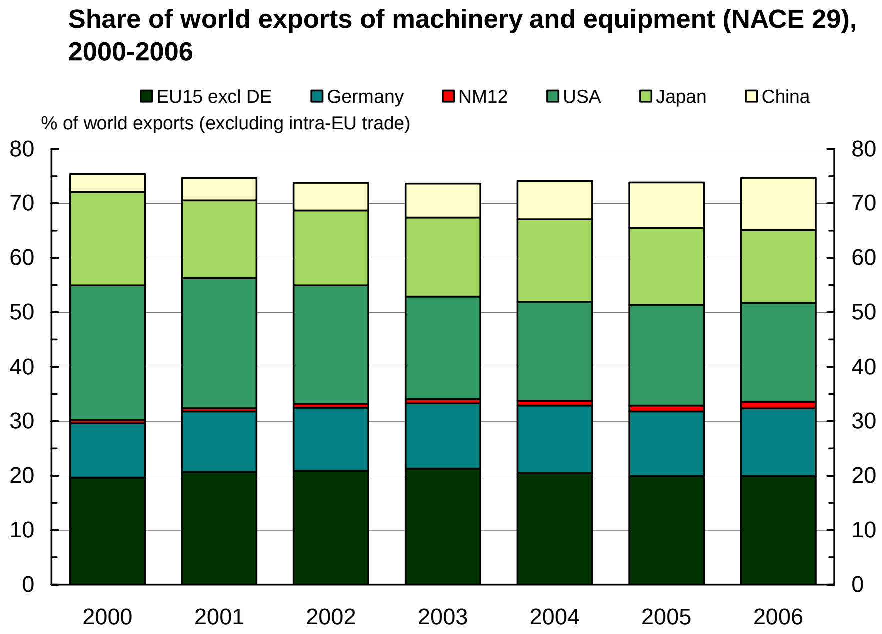
Over the 8 years 1999-2007, the trade balance on electrical engineering products improved by even more than on mechanical engineering products, with an EU deficit with the rest of the world of 1% of the combined value of exports and imports in 1999, being transformed into a surplus of over 12% in 2007. An improvement was achieved in most countries, most notably in Poland and Romania, where it amounted to over 25% of exports plus imports in both cases.

## Trade performance of EU electro-mechanical exporters in global markets

The overall competitiveness of the electro-mechanical sector relative to producers in other parts of the world can be assessed on the basis of United Nations data on the exports of different countries to global markets. Such data also give an indication of the relative importance of EU producers in the global manufacture of the products concerned, insofar as the scale of production is linked with the scale of exports[5].

These data indicate that, in general, EU producers have performed better than those from other developed economies in both parts of the electro-mechanical sector in recent years. In 2006, EU producers accounted for just over a third of total exports of machinery and equipment (i.e. the products included in NACE 29) in global markets, excluding their exports to the EU internal market. This compares with 30% in 2000, though from 2003 on, the share remained broadly unchanged (Figure 1)[6].

**Figure 1**




This increase was predominantly the result of growth in the share of producers in Germany (from 10% to 12.5%) and, to small extent, to a rise in the share of those in the new Member States, though in 2006, these still accounted for only just over 1% of total global exports of products in this sector.

[5] Although this tends to be the case in developed countries, it is not always true in developing ones where industries may specialise in exporting.

[6] The data summarised in this and other bar charts in this section relate to total exports of EU producers to third countries and of producers in other countries to global markets including to the EU.

### Member State contributions to EU trade performance

The large share of Germany in the value-added produced in the EU by both the mechanical engineering and electrical engineering part of the sector is reflected in the equally large share of German manufacturers in EU exports to the rest of the world. In 2007, they accounted for some 37% of total exports of machinery and equipment from the EU to third countries, and for just under 40% of exports of electrical equipment and apparatus. Both figures, moreover, were substantially larger than in 1999 – 32% in each case.

Again reflecting its large share of value-added, Italy was the second largest contributor to EU exports of machinery and equipment, accounting for just over 19% of the total in 2007, also up from its share in 1999, while the UK accounted for 12%, down from just under 16% in 1999 in line with its declining share of value-added. The new Member States taken together were responsible for only around 5% of the total, reflecting the concentration of their exports to other EU countries, though this result was still much higher than 8 years earlier when they accounted for less than 2%.

In the case of electrical equipment and apparatus, France is the second largest contributor to EU exports to the rest of the world, accounting for just over 13% of the total, only around a third of the German share and down by 3 percentage points on its share in 1999. The UK, the third largest contributor, was responsible for just under 11% of the total, down even more substantially from over 16% 8 years earlier. While the new Member States are more important in this part of the sector than in the mechanical engineering part, they still accounted for only just over 8% of exports from the EU to the rest of the world in 2007, though this was more than double their share in 1999.

### EU versus US and Japan shares of the market

The increase in the EU share was accompanied by a decline in the share of producers located in the US and Japan – from 25% in 1999 to 18% in 2006 in the case of the US, and from 17% to just over 13% in the case of Japan. The US decline, however, was only relatively small after 2003, perhaps reflecting the large fall in the exchange rate – just as the increase in the exchange value of the Euro may have dampened the rise in the EU share. At the same time, producers in China (which here include those in Hong Kong) increased their share over the period from just over 3% to almost 10%, while the share of all other producers in the world rose only marginally.

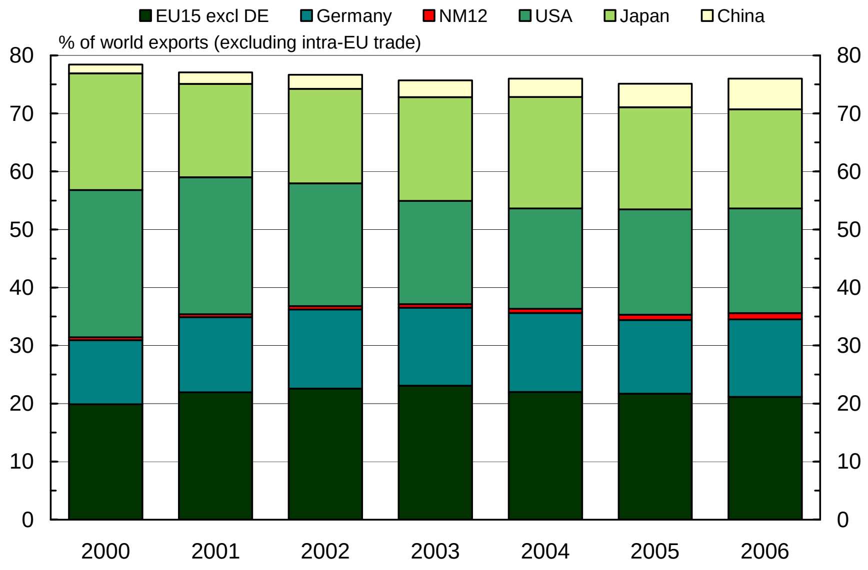
### Trade performance within the manufacturing equipment sub-sectors

The performance of EU producers in global exports markets for the different broad categories of product covered by the NACE 29 sector was similar to their performance in the overall market. EU producers, therefore, were responsible for just under 36% of the market for specialised machinery (which made up 33% of total global market for machinery and equipment) in 2006, up from just over 31% in 2000, though down slightly from 37% in 2003 (Figure 2).

Again the increase was largely accounted for by producers in Germany, which were responsible for 13.5% of the market in 2006 as against 11% 6 years earlier and which unlike those from other part of the EU15 maintained their share after 2003. US and Japanese exporters both lost market share, especially the former, though after 2003, their share increased marginally.

**Figure 2**

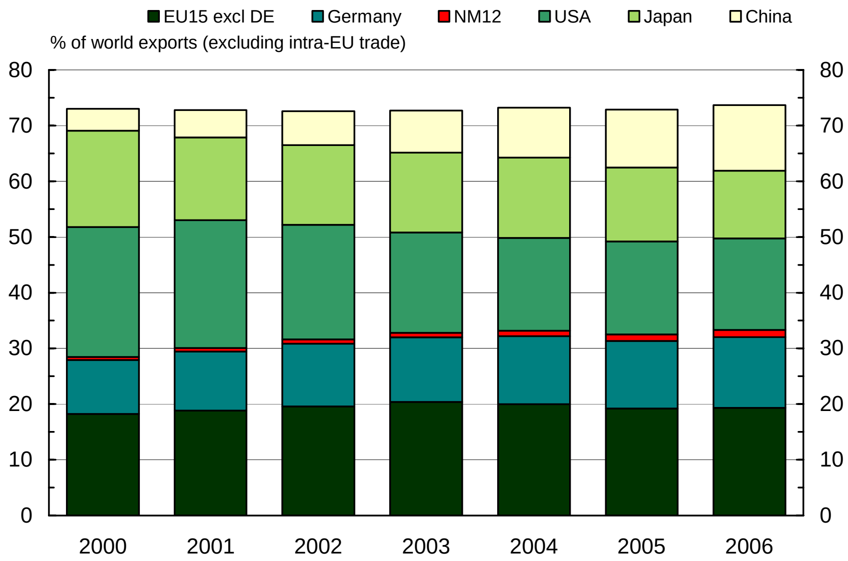
**Share of world exports of machinery specialised for particular industries (SITC 72), 2000-2006**




The share of EU producers in general-purpose machinery and equipment (those included in SITC 74, which made up some 44% of the total market for machinery and equipment) was very much in line with their share of NACE 29 products as a whole, as was the change over the period 2000-2006 (Figure 3).

**Figure 3**

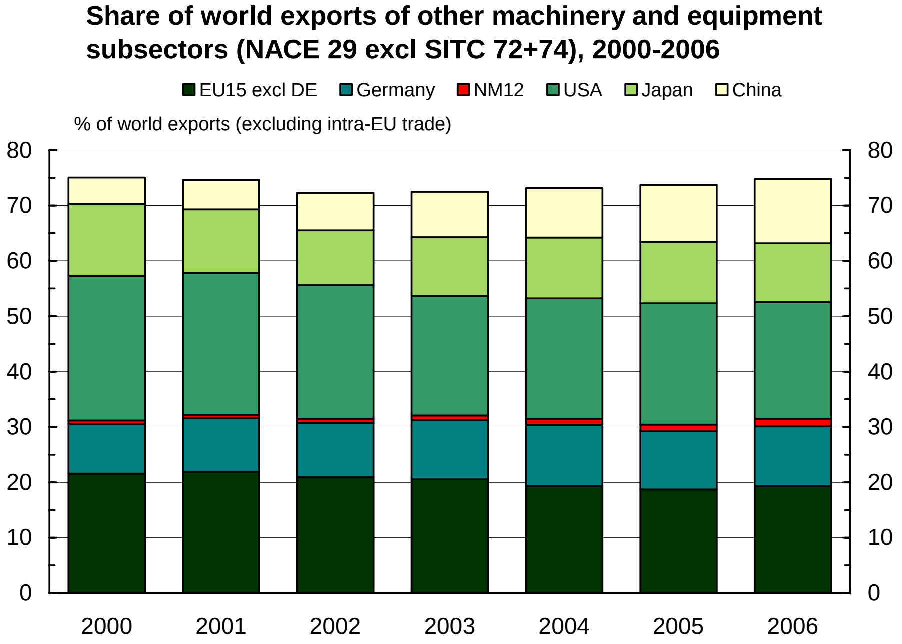
**Share of world exports of general industrial machinery and equipment and machine parts, nes (SITC 74), 2000-2006**




In this case, however, the decline in the US share of exports markets showed less sign of coming to an end during the period, while the Japanese share fell more than for other broad categories of product and the Chinese share rose markedly.

For the other products included in NACE 29 (which include engines and household appliances), which together account for just over 20% of the total, the share of EU producers was slightly smaller (at just over 31%) and was much the same in 2006 as in 2000, though a little lower than in 2003 (Figure 4). The share of both US and Japanese exporters was larger than for other broad categories of product and declined by less over the 6-year period. At the same time, the Chinese share increased markedly, to around 11.5% of the total export market.

**Figure 4**




## Trade performance within the electrical equipment sub-sectors

EU producers are less important in the electrical equipment part of export markets. In 2006, they accounted for just over 18% of total exports of the products concerned (again excluding their exports to other EU Member States – i.e. to the internal market), which was up from 15.5% in 2000 though only marginally above their share in 2003 (Figure 5). German producers alone were responsible for just under 7% of the total and again accounted for all of the increase in the EU share between 2000 and 2006[7]. The new Member States together again accounted for only just over 1% of the total.

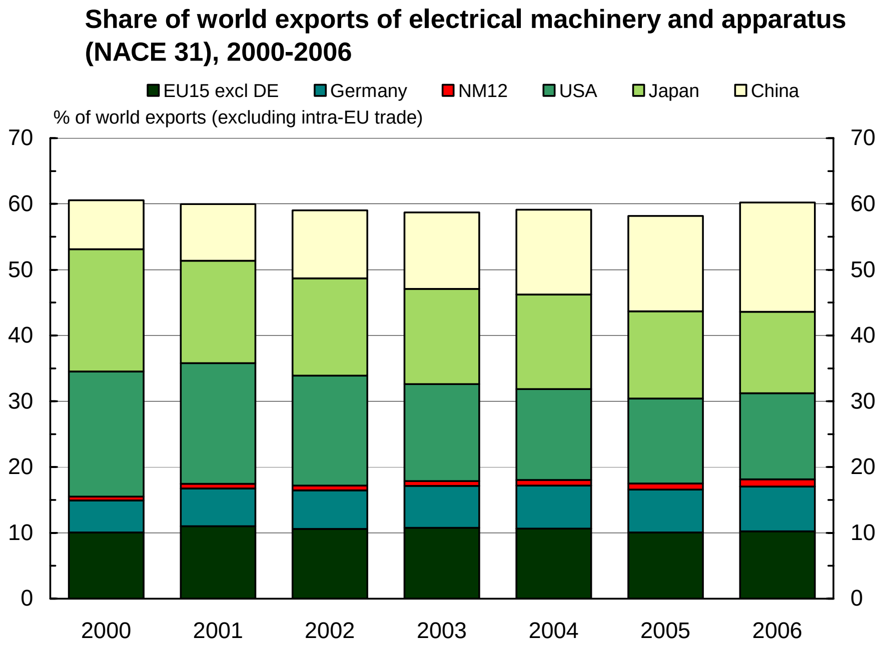
The share of US exporters in this market declined over the period, to 13% of the total in 2006, by much the same as in the market for machinery and equipment, though with a continuing decline after 2003, if at a slower rate. The share of Japanese exporters, however, declined by more, to around 12.5%, while that of Chinese exporters increased even more markedly than in the market for machinery and equipment – to just over 16.5%, only slightly below the EU share, and up from only 7.5% in 2000.

Producers from the rest of the world taken together – in this case to a large extent from south-east Asian economies – are also more important in this market than in that for

[7] German producers according to the UN trade data accounted for just under 38% of the total exports of the EU to third countries in this broad product group which is marginally less than indicated by the Eurostat trade data summarised above (just under 39% in 2006 – and just 40% in 2007).

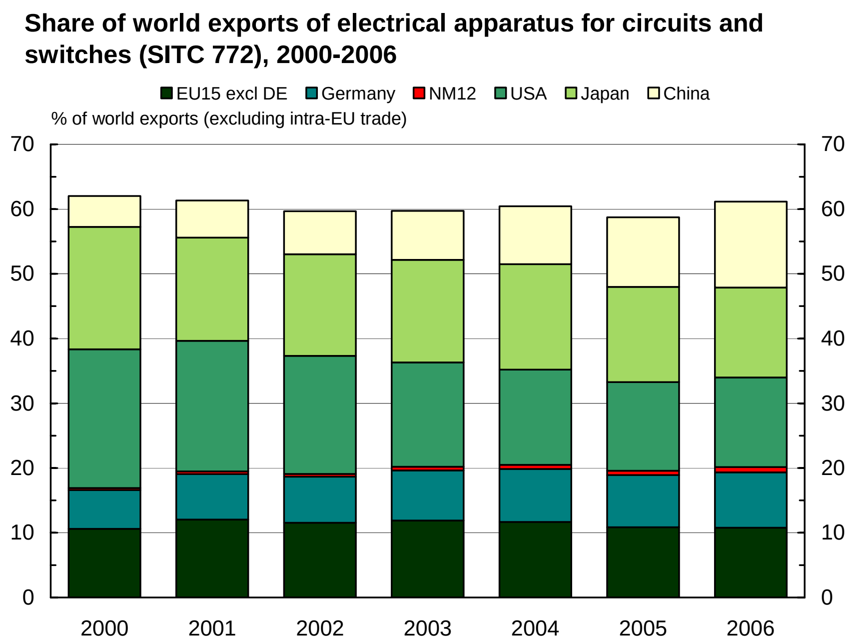
machinery and equipment, accounting for around 40% of the total, though much the same in 2006 as in 2000.

**Figure 5**




The division of exports between countries in broad sections of the market and the pattern of development are similar. EU exporters accounted for just over 20% of the market for circuits and switches (those included in SITC 772) in 2006, which makes up over a third of total global exports of electrical machinery and apparatus, with Germany alone accounting for 8.5% (Figure 6).

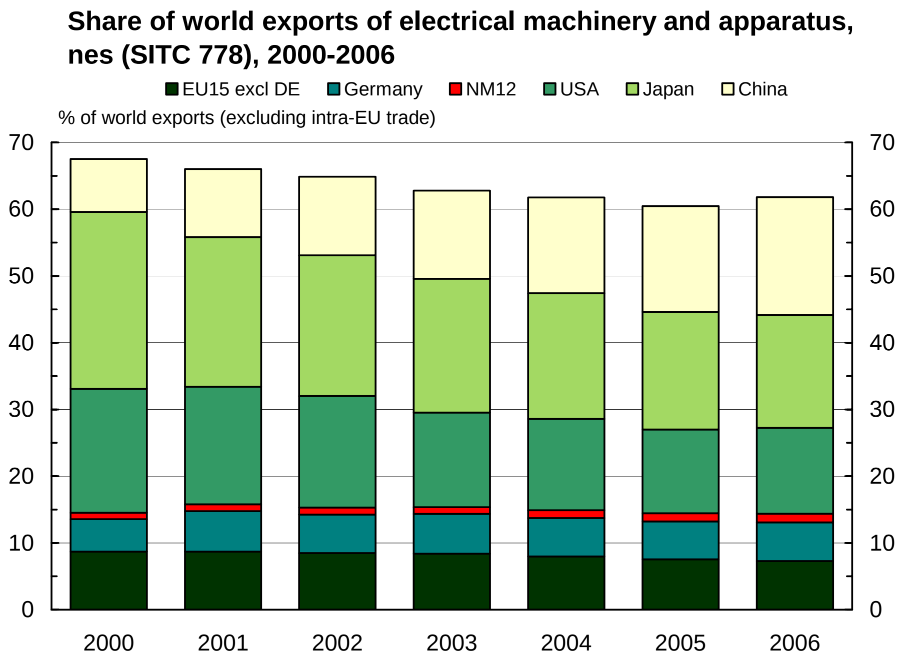
**Figure 6**



In both cases, the shares were higher than in 2000, but in the case of the EU share, much the same as in 2003. In this case, US, Japanese and Chinese exporters were each responsible for 13-14% of the total, though the US share declining by almost 8 percentage points between 2000 and 2006 and the Chinese share expanding by even more than this, while the share of other exporters was much the same in 2006 as in 2000.

The share of EU exporters of the miscellaneous category of electrical engineering products, which includes batteries, electrical tools and signalling equipment (i.e. the products included in SITC 778), which made up just over 27% of the total world exports of sector, amounted to only around 14.5% in 2006, much the same as in 2000 and lower than in 2003 (Figure 7). This was less than the Chinese share (around 17.5%), which increased by almost 10 percentage points over the 6 years to exceed the Japanese share, which declined by much the same amount.

**Figure 7**




The EU share of the other products exported by the electrical engineering sector, which include electric power machinery and equipment for distributing electricity (those included in SITC 716, 771 and 773) and which made up some 38% of the total value of exports of this sector, was larger in 2006 at just under 20%. This was significantly higher than in 2000 (just over 15%) and still slightly more than the share of Chinese producers, which rose at almost twice the rate of the EU share over the period (Figure 8).

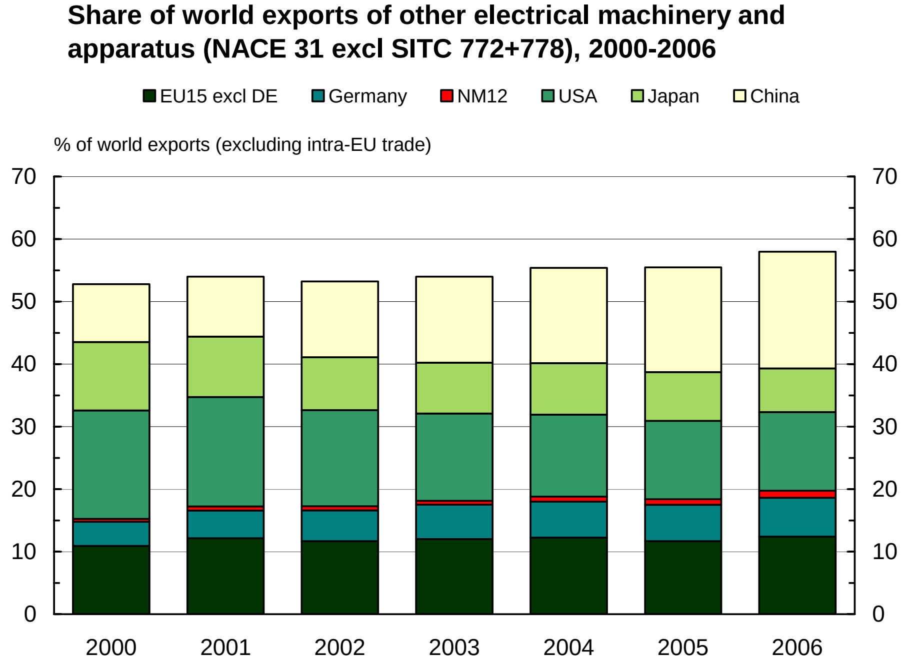
In this case, the decline in the US and Japanese shares was less than for other product groups in the sector and the increase in the Chinese share was at the expense of a fall in the share of producers in other parts of the world (from 47% to 42%).

## Overall trade performance of electro-mechanical sector

In sum, therefore, EU exporters account for a significant share of global markets for most of the products manufactured by the electro-mechanical sector. Moreover, in marked contrast to US and Japanese exporters, they have tended to increase or at least maintain their share of these markets over recent years. This applies in particular to German exporters, whose share of nearly all markets has expanded since 2000.

Although Chinese producers as well as those from other Asian economies have increased their market share for all products groups over this period, this has been mainly at the expense of producers in US and Japan rather than those in the EU. In the case of Japanese producers and, to some extent US multinationals, the decline reflects in part a shift of production of activities from the home country to lower cost locations in neighbouring countries (to South East Asian economies in respect of Japan, and to Mexico in respect of the US).

**Figure 8**



# Part 2 – Drivers of change

For the electro-mechanical industries, the period under review has been characterised by changes in the external, exogenous, economic environment, notably in terms of globalisation, increased EU integration following enlargement and fluctuations in the overall rate of growth of global activity and EU value-added.

In addition, the endogenous situation of firms has also changed – notably in terms of an increasing integration of technology and management as the industries have moved away from selling established products to customers to meeting their increasingly complex and demanding requirements in a more inter-active way.

Such changes – exogenous and endogenous – have affected all countries to some degree, though it is also the case that the industries are highly concentrated in particular regions of particular EU countries. The actual impact in any locality, however, depends on many factors, not least the importance or otherwise of leading firms in different sub-sectors, and the way they, the governments, and other actors including educational and technological agencies, have responded to these developments.

The principle drivers have been characterised as economic, technological and occupational, but also include regulation. In general, economic drivers tend to determine the volume of employment in the sector, while other drivers tend to determine the structure and composition of employment.

Economic drivers are largely exogenous in the sense that the industry depends on the rate of European and world economic growth and development, and the geographical location of the end-product producers who generate the demand for the industry's suppliers

Suppliers, and their sub-contractors, are often obliged to locate their facilities close to those of their customers. This works to the advantage of European producers when the end users are European, and may help off-set cost disadvantages relative to low-wage economies, but it also tends to encourages the relocation of facilities as domestic markets expand elsewhere, notably in Asia.

Exogenous forces that are of particular concern at the moment are the immediate and longer-term impact of the current recession, and whether China and other Asian countries will develop their capital goods industries in the future in competition with established EU firms and industries.

Technological and occupational drivers are essentially endogenous and so more under the control of the industries and individual firms, although they are significantly influenced by public policies, for example in relation to support for R&D. In terms of endogenous forces, the main explanations of changes in the division of jobs in EU15 appear to be technological changes (notably hybrid technologies changing the producer-consumer relationship) *coupled with* organisational changes.

This is resulting in reduced demand for traditional manufacturing skills, but increased demand for managers and other professionals, as well as electricians (the computer effect).

Endogenous drivers – notably the development of hybrid technologies linked to modern, sophisticated production methods, and focused on specific customer needs than in the past – are likely to persist, but the pace of change will be influenced by the fortunes of end users. ***Table 4*** indicates some specific technological and organisational drivers that are likely to determine how the sector will develop in the future.

**Table 4 Structural drivers of change in the electro-mechanical industry**

**Exogenous drivers**
- Changes in the global/European distribution of industry through competition
- Market liberalisation, notably of EU energy markets
- Political priorities on climate change and eco-sustainability

**Endogenous drivers**
Changes in the relationships between industry producers and consumers, involving:
- Technological 'hybridisation' (mechatronics – electronics and mechanics) and increasing 'openness' to innovative methods and processes
- Increasing integration of design, technology and management within companies, leading to new production paradigms

**The machinery and equipment industry**

**New model of 'industrial operations'**
- Agile and lean production - produce more with less
- Just in time, 'kanban' stock control, and logistics systems
- Teamwork culture and systems

**Total quality**
- Operational 'preventive control' systems throughout the industrial process

**Diversified production**
- Balancing customer 'value' benefits with benefits of mass production

**Simultaneous engineering and reduction of time to market**
- Enabling the design and product prototyping phases of product development to be carried out in parallel with the development of the equipment to produce them

***New drivers*** focus on:
- Continued focus on integrating design, computer-aided production, new material and new standards of precision – emphasising links with R&D and universities and research centres

**The electrical machinery and apparatus industry**
Similarities with mechanical engineering sector regarding 'industrial operations' plus:
- Pressures for greater standardisation
- The development of technologies that can improve the efficiency of processes
- Co-design project planning within the factory

***New drivers*** focus on:
- New 'best technologies' investment in energy generation
- The need to exploit alternative energy sources – wind, sea, ground etc
- The need to support energy consumption reductions – among producers and consumers.

Another major issue for the sector is energy and eco-sustainability, given it is a major energy user and user of energy-intensive inputs such as metals. This could, however, give European firms an early lead in delivering energy-efficient products, with consequences clearest for Electrical engineering, but also for some parts of Mechanical engineering.

Less clear is the extent to which the industries can take a collective position at national and EU level, or whether action will be left to individual leading, or innovative, companies. Government responses remain general rather than specific, perhaps reflecting Member State concerns about being accused of promoting or endorsing ‘new industrial policies’, or interfering with market competition.

The reputations of companies – in terms of innovative capacity, product quality, respect for delivery times, etc - are all important determinants of business performance, and changes in perception can have a significant impact on market position. The importance of reputation and risks of litigation are also thought to discourage major European producers from competing at the lower end of the European market, leaving it open to extra-EU competitors.

Intellectual property rights (IPR) are likewise of importance, given that the way brands and brand-names are protected around the world represents a competitive advantage for European-based companies, and is a significant factor affecting market position. In this respect, concerns about protecting intellectual property and know-how may discourage companies from pursuing outsourcing strategies based on cost/quality factors alone.

The geographical location of industry activities are generally based on the needs and demands of customers. However, the current locations of many production plants and other facilities may prove a long-term negative factor as the companies concerned seek to recruit more highly qualified personnel, in competition with many other sectors, outside and well as inside manufacturing, given the apparent preferences of many young professionals to seek a better work-life balance by locating themselves in more urban environments.

The electro-mechanical sector is so diverse and linked to so many different areas of the economy, with considerable differences within and between its different components and Member States, that it is difficult to treat it as a sector, in the normal sense of the word. Firstly, there are major differences within the sector. Output in both sub-sectors is driven by both global and European demand, but the electrical machinery sector is more focused on European markets, and more influenced by national market conditions, which tend, in general, to favour national producers. Liberalisation of the energy production sectors could, therefore, bring significant changes.

There are also major differences between Member States in that the importance of the sector varies considerably between Member States, with differences in structure, organisation and competitiveness (as revealed by trade performance). General drivers of change are unlikely to have the same effect in all counties, therefore, nor are there likely to be common responses to drivers.

Changes are impacting differently on the new Member States compared with EU15. In particular, some of the changes in the structure of sectors in the new Member States appear primarily driven by out-sourcing from EU15 and changes in product specialisation following enlargement. This is reflected in the expansion of demand for semi-skilled workers and the decline in demand for traditional, apprenticeship-based, engineering skills. The sustainability of these activities depends primarily on the cost competitiveness of the countries relative to non-EU suppliers.

Overall, the main trends that provide the background to the production of goods and services by the electromechanical sector can be considered in terms of:

- changes in the global and European distribution of its industrial activities;

- changes in the interaction between the industry producers and their consumers;
- growing technological 'hybridisation' and an increasing 'openness' across the industry with respect to the adoption of innovative methods and processes;
- developments in the regulatory environment, in terms of both market liberalisation and policy with respect to energy use.

**Changes in the global and regional distribution of activities**

Until the mid 1990s, there was a fairly clear division of labour between the EU15 countries and those countries that were outside the EU, but have subsequently joined. This enlargement of the EU has, however, led to a growing integration of these markets, which has brought changes in the distribution of industrial activities across European countries, and an associated modification in production methods.

In other words, companies and countries have learned to concentrate their resources on what they do best, discovering where they have a competitive advantage to be exploited, and generating new value from their ability to combine products/activities made 'at home' with those made 'outside'.

The overall quantitative impact on employment of all developments – economic, technological and organisational - has been indicated in Part 1, but it is also possible to consider more qualitative movements. In this respect, it would appear that the shift of activities to and within the new Member States has been largely limited to the first stages of the 'sectioning' process of the value chain (to use Krugman's expression) given the limited availability in the countries concerned of the high professional qualifications required for other steps in the chain.

The conventional view is that this process of integration should be seen as a 'long term' trend, although it is not clear how long this trend will continue. The possibility cannot be excluded that the opening of new markets in Asian areas - given the supply of low cost labour and the availability of knowledge and skills generated by ongoing commitment in the technologies of the future - may generate conditions that are favourable for the migration of activities, and the growth of new production initiatives outside the EU, as well as for further movements within the EU 27 territory.

**The changing interaction between producers and consumers**

The interaction between producers and consumers was subject to significant change during the 1990s. The importance of 'user functions' i.e. the 'value' users attribute to products and services - has progressed to the point that it has now become the main 'guiding principle' for manufacturers.

Alongside this, there has also been the appearance of 'social functions' largely imposed on manufacturers by regulations drawn up by public authorities to protect the environment, guarantee worker safety and protect the public in general. There are a number of examples: regulations on car emissions and on transport vehicles (for people and goods) as set out in European laws, and rendered progressively stricter in the interest of environmental compatibility.

Similarly, increased awareness among users of the unavoidable impact of external factors (e.g. increasing energy costs) has led to an interaction of two functions in the purchasing decisions of consumer, starting with those who are more demanding or sophisticated. In short, the ‘power’ of the consumer has progressively increased, within a context of intense competition, and the attention devoted to ‘user/social functions’ is progressively replacing the earlier ‘factory-centred’ perspective of much of the sector.

This has also led to changes in the relationships between final-product companies and their suppliers within a partnership context, in which each link in the industrial chain represents the value of competences incorporated in relation to the improvement of the overall result.

**Technological hybridisation**

The phenomenon of ‘technological hybridisation’ in a key element in the application of technology over the period, with innovative processes becoming ever more ‘open’, with increases in the technological sophistication of products and production systems depending, not only on the evolution of specific technologies, but on the technology and know-how resources located in external businesses.

This phenomenon is most clearly evident in the automotive industry which has acquired a new dynamism from electronics, which have been responsible for a significant proportion of the innovations introduced, and whose share in the value of cars that has risen markedly.

The development of ‘mechatronics’ is another example of how the merging of two technologies - mechanics and electronics - has led to a new production paradigm, which in turn is giving rise to a generation of new products with widely differentiated uses, both civil and industrial.

Overall these general factors for change are creating a situation in which it is vital for firms to be able to manage ‘open’ innovation, without any barriers thanks to ICT technology, as well as to develop efficient inter-organisational working arrangements.

**Regulatory environment**

Energy and eco-compatibility constitute common priorities for the two industries in the near future. In terms of energy, some experts in the oil industry declared in the recent past that the price per barrel of oil would not exceed 45 US dollars (an upper limit foreseen in a 1990s study by the World Bank and which triggered the launch of serious alternative fuel solutions). Subsequently, estimates have pointed to a possible ceiling over the medium term of around US 240 dollars. In other words, uncertainties about energy prices are likely to extend into the future.

Such uncertainties limit the formulation of plausible hypotheses concerning a variable that is critical for company finances – particularly those with a high rate of energy consumption, forcing them to totally review their processes and costs. The mechanical and electrical engineering industries, given their features, can be included in this category and it likely, therefore, that there will be a common orientation towards less intense energy-consuming technologies. Production processes in the electro-mechanical sector will therefore be pushed towards eco-efficiency.

Energy consumption will, accordingly, tend to be a constraining driver over the coming years, and companies that take early initiatives in this regard and can shorten lead times will be the successful ones.

**Concern for eco-sustainability**

Public sensitivity regarding environmental matters is increasing so rapidly that anything that can encourage eco-sustainability, while safeguarding user expectations, is likely to be rewarded by growth in demand. The need to respond to mass customisation and problems linked to supplies from distant companies, the demand for greater quality, together with the need for costs and delivery terms control, will require new approaches combining leanness and agility with sustainability.

In this context, ergonomic advances that maximise machine efficiency need to be matched by ergonomics that defend the health of operators, recognising that the repetitive sequence of machine operator movements can give rise to professional illnesses and serious skeleto-muscular problems. In this respect, the potential to simulate operator movements should make it possible for machine designers to achieve significant improvements.

#### Market liberalisation

The factor that is most likely to have a major impact on the future of the sector is EU-wide market liberalisation and the potential break-up of national monopolies. Prior to liberalisation, the European energy generation system had been dominated by large national companies, often controlled or regulated by the State, with large numbers of small and medium sized supplier companies linked to them through long standing relationships.

Driven by this new market 'revolution', larger companies in Europe are having to consider how best to develop more efficient energy generation models in already existing sites, as well to accelerate processes of technical and commercial innovation and customer research beyond national frontiers. Likewise, many SMEs, which will no longer enjoy the protective 'umbrella' provided by contracts with large monopolistic companies, are having to emphasise their specialisations and focus on new customer research in order to continue in operation.

In the final analysis, the important driver for change or transformation in this respect will be openness towards comprehensive competition, and the need to promote and pursue excellence on an international level. The industry has, therefore, taken the first steps towards a growing trans-frontier concentration. Some players have adopted vertical integration strategies which, in turn, have led to mergers and acquisitions among operators with respect to both gas and electricity supply. The new competitive panorama has promoted an expansionary process, which has not yet finished, involving an extended transmission network on a pan-European scale for the distribution of both electricity and gas.

### Specific drivers within the machinery and equipment industry

Over the past decade, the evolutionary process has been characterised by the introduction of a range of specific innovations, as set out below.

#### Industrial operations

During the period the Japanese model of industrial organisation has been diffused in western companies, as well as around the world. This, along with progress made in the technological field, has as its most visible paradigm combining product strategies with manufacturing strategies.

The biggest change has been the introduction, within the company culture, of the principle of joint product and process development i.e. the expectations of the 'user' or customer has become accepted as being a key part of product development. Now everything is integrated in a single activity, whereas in the past, production was associated solely with 'the factory'. It is now considered negative to separate design from production, just as it is negative to regard production as a separate entity from design. This view has developed to such an extent that the term 'production' has now been replaced by the new term 'industrial operations'.

Likewise, while marketing was previously focused on product placement, the development of the product now constitutes an 'industrial process' that comprises design, industrialisation, manufacturing and purchasing. This approach has eliminated barriers between various activities and has created enormous advantages in terms of time and costs.

### Agile and lean production

The objective of lean production is essentially to allow companies to produce more using less: less equipment, fewer employees, shorter process times, better organisation. The paradigm of 'lean production' includes the concept of a hierarchically lean structure, one that encourages the delegation of responsibilities so that problems are tackled and resolved at the point of greatest competence. This requires management to develop a teamwork culture. The same applies with respect to the application of modular manufacturing systems, that are easier to manage and maintain and which involve greater machine control and flexibility.

This aim that has been driven by competition and while it largely started in a specific national context, is now being extended on an international basis. Methods like 'just in time', 'kanban'[8] stock control, or systems like logistics or tertiarisation, which were 'cutting edge' techniques in the industrial world in previous periods, have now become mainstream operational practices, resulting in major production efficiency gains. However, such a leaner, lighter production that reduces overall costs, generally requires extensive use of automation.

### Total quality

The 'total quality' approach involves the adoption of operational 'preventive control' systems, which start with design or parts lists and continues throughout the entire industrial process, reaching out to the activities of suppliers, using software that make it possible to monitor the process and reduce errors, breakages and accidents and hence bring benefits to customers and strengthen the company image.

In other words, the production process is guided by a series of controls, equipped with dedicated software that highlights errors or 'derogation' from procedures. This approach puts the final customer 'centre stage', and drives ongoing improvements.

### Progressively more diversified production

A complementary aspect or, arguably, another driver for change is the increased attention paid by industry to 'user functions', which have been particularly influential during this period. In the 1970s and 1980s, attention was focused on 'marketing' as industry starting from a basic product, and had to offer more distinct, more customised, or richer 'assets' in order to capture customers. This, in turn, led to increased technological sophistication with a massive injection of electronics into the industrial process, with the eventual development of mechatronics, involving the widespread use of more evolved robots.

[8] A signalling device to trigger action.

This new form of automation has made the overall process of production more flexible, which favours greater diversification, and permits increased variety in the supply of available products. Within all this, however, the manufacturer, while paying considerable attention to 'user functions' is nevertheless seeking to maintain a production approach that is oriented towards mass production.

These developments represent a significant change from previous culture approaches (without citing the extreme, and actually apocryphal, story of all Ford vehicles having to be painted black for economic and standardisation reasons) which were strongly centred on 'maker functions' i.e. on the interests of the factory, with systems of mass production that were less well oriented, or much less sensitive, to market demand.

To respond to these market oriented considerations, production plants have become partially broken up (de-composed) and organised in sections, islands and operational modalities that allowed for production enrichment and customisation. Process follows product; mechanics are enriched with contents, with the processes increasingly combining automation with flexible customisation.

**Logistics, 'just in time', kanban systems**

In the second half of the 1970s, some firms in the engineering industries began to adopt a new generation of informatics systems, in which software models had been specifically designed to ensure the efficient management of supplies of components, sub-assemblies or materials. During the 1980s, while logistics processes moved forward in terms of factory and distribution networks, production programming and supplies were still carried out in 'cascade' fashion, along the supply chain, with periodic re-ordering, although the production flow became leaner with respect to the previous period.

However, during the 1990s, the availability of new ICT systems and the development of the web made it possible to make more profound changes. Logistics moved from a simple company function to an 'integrated transversal' system supporting 'supply chain management' that was able to verify production flows progress and process efficiency through, among other things, time measurement (material entry times and output times for the same assembled material)

However, the Japanese industrial culture, on which these practices were based, had also shown the potential advantages of 'travelling warehouses' i.e. only holding those supplies strictly required for the process on site, with stockholding in the supplier's warehouse or transport vehicles, bringing major inventory cost savings. Such logistics advances have been very significant drivers internationally - widely acknowledged as having contributed to America's high productivity performance in the 1990s.

**Team work**

Team work changes have been driven by changes in patterns of work organisation, and changes in functions and tasks, which have brought to the fore the need to delegate responsibilities to staff at all levels, from product design and development, through to systems of production, storage and customer service. This has also, in many cases, been associated with changing working time arrangements and increases in flelxibilitiy in a number of respects, as required by customer needs as much as the needs of machines.

**Reduction of time to market**

Innovation has made it possible for the design and product prototyping phases of product development to be carried out in parallel with the development of the equipment to produce them – known as simultaneous engineering. The progress and advantages resulting from this solution can be seen above all in the reduction of resources dedicated to manufacturing.

Previously, products coming off assembly line systems had to be stored, at high cost, in order to ensure a rapid response to market demands. It was therefore necessary to make processes more rapid and at the same time reduce finished product stocks while awaiting distribution to final customers, thereby operating much faster processes and more advanced and effective logistics. Over the last decade such requirements have become increasingly important and a prime strategic objective for companies.

**Maximum use and minimum unit operating cost of manufacturing systems**

Here too, on the assumption that manufacturing programmes are stable or progressively growing, innovation has been aimed at maximising resources to improve company profit margins. To conclude on this point, the most important drivers over the last decade include greater operational flexibility and the lean factory, with greater attention focused on customer requirements, time and stock reductions, and the enrichment of automatic instrumentation.

### Specific drivers within the electrical machinery and apparatus industry

As regards the organisation of ‘industrial operations’, there are some similarities between the electrical machinery and the mechanical engineering sector, with many of the drivers listed above equally valid for the electrical engineering sector. This is understandable given that the various elements that have been assimilated in the industrial culture have affected almost all industrial activities, especially those relatively close to mechanics.

So far as electrical generators and electrical distribution equipment are concerned, there is a connection between manufacturing strategies and product strategies, which give rise to ‘co-design’ through direct contact and close collaboration with production. It must also be borne in mind that, in the electro-mechanical sector, unlike mechanics, the product may be manufactured in relatively small numbers and hence the opportunities for ‘repeatability’ are minimal. This in turn creates a need for a continuous comparison and contrast with production from the very start of the design.

The analogies here include the principle of lean production, even if orders involve smaller quantities, as well as logistics and supply chain management. There is, therefore, a focus in this sector as well on reductions in ‘time to market’ (to lower the cost of component stocks) and on total quality (to verify process efficiency through to suppliers and the product definition phase).

New technologies have also led to changes in the typical typologies of machines. For example, there has been a shift to gas turbines and the growing use of air cooled machines. Ultimately all manufacturers have extended the field of application to comprise greater power and machine simplification.

Overall the decisive drivers in these respects over the last decade have been:

- greater standardisation, realised by limiting typologies and technologies (in other words, reducing the number of variants while improving the overall quality of plant equipment);
- the strengthening of technologies that can act on processes, generating information systems, CAD-CAM systems, and extensive use of ICT;
- co-design project planning within the factory, including variations in cooling and insulation, variations in structural mechanics, and the introduction of new materials and new construction morphologies.

However, it must also be said that, although progress has been made with respect to individual technologies, advances have in general been slower and more incremental than in the mechanical engineering industry, which can be, partly at least, attributed to monopolistic conditions in the national markets for some major electrical industry products. In such circumstances, large companies have often undertaken new capacity-building investment without necessarily being required to adopt the latest innovations or face competition.

## New drivers in the future

It is widely accepted that the endogenous drivers that have driven changes in mechanical and electrical engineering production over the last decade or more will, for the most part, continue to operate over the coming decade, recognising that the process of modernisation generally proceeds through ‘progressive accumulation’ in which some firms act well before others but where, over time, more and more firms gradually ‘up-grade’ to the new, higher, standards.

That said, it is important to consider whether there are new drivers that can be added to previous ones, reinforcing their potential and opening up new innovative pathways.

### R&D and industrial exploitation capacity

Future competition will continue to be played out, not only in terms of research activity levels, but also in terms of the ability to support any drivers that emerge and to fully exploit the results in terms of a prompt arrival to market. This future embraces a major expansion and extension of know-how linked to the internationalisation of research and the preparation and training of workers, with a related focus on the skills and specialisation of the workforce.

As regards trends in the internationalisation of research, it is evident that, since the mid-1990s, expenditure by multinationals in the industry increased worldwide in percentage terms more quickly than turnover and imports. Only direct investment shows similar growth because of mergers and acquisitions during the period, most especially since 2000. R&D is, therefore, one of the most dynamic elements in the globalisation process.

As regards the re-skilling of workers, it should be noted that the redefinition of company production and organisation structures, as outlined above (lean production, ‘just in time’, total quality and so on), together with the acceleration of technological progress, has increased the risks of rapid obsolescence as regards individual know-how, thereby leading to greater attention being placed on permanent professional re-qualification (life-long learning).

All of which means, as regards production personnel, that preliminary training activity, training on the job and correct assignment of roles and tasks are decisive elements in accelerating the learning curve. All of the above is vital in increasing production rates and, in turn, contributing to achieving ‘time to market’ targets and to increasing the ‘value’ of new products.

The coordination of know-how and skills requires new and robust development, however. As regards mechanical engineering, it is necessary to promote an integrated approach based on the skills and methods of the various scientific-technical sectors which promotes synergies. At the same time, didactic matters are important, notably the continuous monitoring of the curricula of mechanical engineering studies, which will need to promote the development of innovative theoretical learning and practical application methodologies.

More specifically, the need for a systematic connection between R&D and advanced design is seen as essential to ensure the competitiveness of machines over the coming years. Moreover, the consensus of experts is that the inclusion of R&D activities in the industrial production chain represents one of the decisive factors for ensuring the continued evolution and innovation of the industrial apparatus.

## A question of balance

The identification of drivers and paths of evolution for the two sectors over the medium and long term cannot be viewed separately from more general considerations regarding the fundamental elements of knowledge and operational activity which must, over the coming years, achieve optimum levels of interaction and fill in the gap that has been noted in past years.

Four factors ate of fundamental importance for the development of industrial and scientific activity:

- hardware: the ability to construct more powerful computers;
- software: the capacity to programme greater computer intelligence and to further integrate computers with operating machines in order to crate an effective operating system;
- ‘orgware’: the organisational capacity of companies, not just in strictly technical terms, but also with regard to interaction with global markets – i.e. the ability to coordinate extensive networks of expertise and development’
- ‘workerware’: the capacity to extend and refine the know-how of operators and other employees in order to exploit computer potentiality fully – i.e. to match the pace of development of hardware and software through training and the acquisition of the skills required in relation to the new tasks.

However, available evidence suggests that progress in relation to hardware and software has been much faster, and quantitatively more important, than progress in relation to the capacity for companies to reorganise and for the skills of the workforce to adapt.

Therefore, according to experts, there exists a ‘fundamental’ gap that has to be bridged or overcome in future years, in relation to the evolution of patterns of company organisation and the technical-scientific culture more generally.

## Specific hypotheses concerning the machinery and equipment industry

Available studies suggest three main areas of technological advance:

- innovative methods for mechanical engineering (technologies for design; simulation and integrated design, noise and vibrations)
- intelligent mechanical systems (mechatronics and automation, sensors, automation and automation systems for the mechanical engineering industry)
- Specific materials and nano-manufacturing (materials and surfaces for nano manufacturing, materials for advanced design, surfaces and the overlap between advanced mechanics and nano-mechanics).

These fields, which include many research subjects and application areas, provide some reasonably clear indications of the paths innovation is likely to take over the coming years. Specifically, the drivers of greatest significance over the medium and loner term are likely to be as follows.

### Redesign and reconfiguration of machines and increased intelligence

The aim is to meet a set of complementary objectives that can be summarised as efficiency and standardisation, the optimisation of processes, the integration of systems, the organisation of space to increase the speed of processes, and the improvement of product quality control.

'Reconfigurable Machining Systems' (RMS) make it possible to respond rapidly to a market characterised by levels of demand that change frequently, to the need to configure new products, and more generally to the improvement of current technologies for manufacturing activities.

Reductions in the times required to introduce new products on to the market characterised by high quality and low costs is a question of survival for businesses (recalling that reduction in 'time to market' was an important driver in the past decade).

If these are the objectives, the upgrading of mechanical systems can be achieved by working on some aspects of production activity. More specifically:

- Researching more intelligent and integrated structural solutions. This will require major modifications to the design and development of machinery. To meet the technological challenge in the future will require the availability of new intelligent and compound materials the elasto-dynamic response of which can be adapted in real time in order to improve the performances of mechanical systems, such as machinery in an extensive range of operating conditions.
- The need to mechanise and automate production processes. Product quality and reduction in development time will assume increasing importance. At the same time designers lack the time needed to carry out tests. Companies must therefore make sure they have instruments and methods that make it possible to intervene ahead of product defects and breakdowns, such as through recourse to a prototype system of design support.
- The introduction of production processes aimed at efficiency, standardisation and synchronisation of machines, which means efficient software and hardware systems.

- The rapid updating of a company's product lines in order to maintain and increase market shares.
- Greater speed of operations through the rapid reconfiguration of machines. The need to develop reconfigurable systems reflects the growing need for the industry to respond promptly to emerging demand.

**Smart manufacturing**

The following section addresses various aspects of 'smart manufacturing' which, taken together, provide indications of their functioning and their potential impact on technological progress over the medium and longer-term:

- Major progress in the design and development of machinery, in order to obtain more intelligent structural solutions, which means more widespread use of information technology in the organisation and control of machines..
- Improvement of systems and processes through new programming, with an important impact on company performances because they are able to ensure better use of production resources and improve the quality of service offered to customers.
- The introduction of new 'standard for exchanging product data' systems (SEPD) intended to improve the definition of machine tasks, enabling economies to be achieved relative to the number of designs and the realisation of intelligent manufacturing.
- 'Open Architecture Control' systems (OAC), that make it possible for users to choose the hardware and software components that they prefer for their machines, achieving greater flexibility and reduced maintenance without increased costs.
- 'Enterprise modelling and integration' type systems that facilitate international scale collaboration with small and medium size supplier companies.
- The greater standardisation and synchronisation of machines around European and international standards.

**Mechatronics and robotics**

Over time, innovative processes are becoming ever more 'open'. Accordingly, improvements in the technological level of products and processes increasingly depend, not only on the evolution of specific technologies, but on the acquisition of technology resources and know-how deriving from related businesses and areas of expertise.

In this respect, mechatronics refers to a flexible and multi-technology approach involving the integration of mechanical engineering, computer engineering, electronics and information science. This is an essential instrument in the design of intelligent products. In the future, trade in intelligent products equipped with greater flexibility, performance, reliability and ease of maintenance will be a key determinant of competitiveness in the mechanical engineering sector, where it at present represents the leading edge of technology.

Such advances clearly require considerable investment in both research and training. The research areas that need to be explored include:

- The robotics sector, which is multidisciplinary in character; given that robots are machines controlled by computers, advances in the hardware and software of computers are of obvious importance in this respect.
- Advances in the speed and ability of microprocessors, which lead directly to increasing the speed and capacity of robots. Many of technologies concerning sensors are still in their infancy but with a considerable potential for growth, not least in relation to robot intelligence, as unit costs fall.
- The possibility of increasing the number of robots used in manufacturing round the world, which needs to be seen in relation to the importance of improving quality and productivity and lowering production costs.

In the above respects, economies like China or India offer significant growth opportunities for robot manufacturers. Some manufacturing firms have already located in China given the considerable growth prospects for its motor vehicle industry, which is a major user of robots in its assembly lines. It has been estimated that another 100,000 robots will be used in China by 2015 for a variety of different applications. On the other hand, from a European prospective, there is the possibility that, over the next 20 years, robots constructed in China (which has not yet developed its own industry in this sector) could be competitive on the world market.

To summarise, intelligent machines offer much potential and there are considerable expectations in the mechanical and electrical engineering industry. Indeed, one of the main reasons for committing resources to the development of robots is in order to provide even greater flexibility relative to the levels of automation that have been achieved so far.

Today, a robotics society requires expertise in many disciplines (mechanical, electrical, industrial engineering, computer science). Even more than this, however, companies need knowledge concerning the specific environment relative to the needs of customers and the personnel able to integrate robots into the production system. This, in turn, requires a consistent commitment to training employees, taking account of the changing balance between different categories of specialist staff inside companies.

At the moment, hundreds of universities round the world have research programmes in the robotics field and many major manufacturers encourage and support their research activities. Manufacturers continue to incrementally improve the robots industry with the aim of achieving greater functionality and flexibility while keeping a constant eye on possibilities of reducing costs. In addition to this, they are also opening up other robot utilisation prospects in areas like ‘domotics’ (home automation), health and agriculture.

### Specific hypotheses concerning the electrical machinery and apparatus industry

The future of this core industrial sector depends to a large extent on exogenous decisions taken outside the industry itself. Companies at present, therefore, in an uncertain and somewhat complicated situation given the uncertainty surrounding energy supply and prices, environmental constraints, and market changes.

A recent report of the International Energy Agency[9], forecasts an overall increase in global demand for electricity of almost 80% by 2030 (as compared with 2004. At the same time, the EU has made significant commitments to reducing CO2 emissions by 20% by 2020, but which it will be difficult for many countries, if not for the EU as a whole, to meet.

Concern and uncertainty about the future have served to focus attention on three primary objectives:

- The need to orient new investment to use ‘the best technologies’ and renew existing generators
- The need to exploit alternative energy sources
- The need to reduce energy consumption levels

At the moment, Europe remains a ‘highly vulnerable area’ in terms of energy, with pressures to increase private sector competition and reduce dependency on public utilities, though with significant differences between EU countries.

Equally, there are significant differences in the relative importance attached to alternative fuels to be used in electricity generation:

- Germany, coal, then nuclear and renewable sources
- France, nuclear, then hydroelectric and coal
- Italy, gas, then oil, hydroelectric and coal
- the UK, gas, then coal and nuclear

In this varied context, the prevailing drivers will depend on relative success in relation to:

- R&D into improvements in harnessing traditional sources of power
- Research into the development of alternative sources of power – wind, sea, sun, etc.
- The development of a new, more efficient, generation of electricity generating plants.

As regard specific factors, the following provides a brief overview

**Developments in the use of traditional sources of fuel**

The burning of fossil fuels currently plays an important role in the generation of electricity in every country, and will continue to play some role in the foreseeable future. A primary aim, however, is to use these sources ‘cleanly’. This objective is being pursued partly via the increased use of natural gas, and partly through a diversification of sources, including the use of coal as a low-cost energy source, which implies the development of effective ‘clean coal’ technologies, including the capture and sequestration of CO2 (CCS technology), will means a considerable commitment to research and investment over the long term.

[9] World Energy and economic outlook.

**Improvements in supply networks**

There is a need for the development of less environmentally damaging systems and components, such as in relation to underground cables and laying technologies (e.g. no-dig), the renewal and upgrading of existing power supply lines and compact and modular substations.

**Control, supervision and protection systems**

There is considerable potential for the development of technologies to help maintain the continuity and quality of electricity energy supplies via improved protection, supervision and control systems, with extensive use of ICT technologies.

**Distribution development**

Existing and future technologies for improving distribution are likely to be linked with automation solutions and services aimed at maximising use and reducing ‘operation and maintenance’ costs and intervention times.

**Alternative sources of power**

Global efforts in this area will be focused, not only on improving existing production processes using emerging technologies, but on:

- Finding new energy sources and new production systems that are reliable and compatible with environmental, efficacy and costs concerns
- Reducing energy consumption levels.

The following provides a brief overview in these respects.

*Thermodynamic solar systems*

Continued developments can be foreseen in relation to thermodynamic solar systems, with linear parabolic collectors that provide technologies with innovative contents for the main plant components (heat transport fluid, thermal accumulation, receiver pipe) with advantages in terms of yield, environmental impact and cost reduction. In parallel to these developments, there are likely to be spill-over -on effects in applying thermodynamic solar energy for desalinisation of water or the combined production of electricity, heat and cooling.

*Wind*

Germany is carrying out an ambitious programme of wind energy production development. At the moment it produces 40% of the world’s wind energy and 16,000 wind turbines are in operation in the north of the country. Other countries with significant development programmes include the Netherlands, France, Spain, the UK, Greece and Denmark.

The remaining EU countries are further behind, but are launching initiatives on the basis of established programmes. The potential for further development is considerable, with many companies in the aeronautics and electromechanical sector able to design and manufacture both aero-generators and wind stations.

*Mini-hydroelectric*

This is a sector in which some European countries enjoy global leadership (Germany, France, Austria and the Czech Republic) both in the design and construction of turbines as well as the building of plants.

*Geo-thermal*

Techniques for the direct utilisation of medium and low temperature heat from the ground have been developed only to a limited extent in the past, but by 2020, there could be a significant increase in installed geo-thermal heat pump capacity for various purposes.

*Solar collectors*

In many European countries the level of use remains limited. A major obstacle is seen to be the low level of qualification of both installers and designers, together with aesthetic objections to their location and visual impact. If these problems are resolved, this could lead to major growth in the future.

*Biomass systems*

Over the coming years the contribution of biomass is expected to continue to grow. The technologies used to date involve combustion, while those relative to gasification are currently in the development and demonstration phase.

*Hydrogen and fuel cells*

The prospects for potentially important technology advance have to be seen in a long-term perspective. At the moment the focus is still on research, development and demonstration, absorbing significant public resources. Programmes underway involve high temperature cells and polymeric electrolyte cells (carbonate cells for cogeneration). Prototype vehicles are in operation, but a considerable level of commitment is needed in order to achieve results that can be put into operation on an industrial scale.

*Distributed generation*

The analytical work currently underway is expected to lead, over the coming years, to a clarification of many of the technical and policy issues regarding distributed generation (DG) – i.e. energy that is generated locally rather than centrally as at present – with further proposals for encouraging distributed generation to be fed into the current energy system.

*Nuclear*

Nuclear power potentially offers a solution to future energy need, but it is one which there are very divergent views and experiences. Some countries have had plants and abandoned them, some have never had them, some are considering new construction, and some face the challenge of updating older power stations and finding solutions to safety concerns.

Research over the next two decades will be focused on providing fourth generation nuclear power. However, any new projects will need to ensure compliance with the Kyoto agreements as well as providing safe solutions regarding sites and the disposal of radioactive waste.

## Containing consumption

One of the main assumptions, on which there seems almost unanimous consensus, is that the global demand for energy will continue to grow over the coming years. At present industry currently consumes approximately 30% of the primary energy used in the world, and is responsible for more than 23% of CO2 emissions. On the other hand, the potential savings in energy use are considerable (25% as of 2020 in Europe) using optimal production processes and more efficient technologies.

This reflects the fact that the most existing energy conversion systems are highly inefficient relative to the best technologies. The potential for intervening to improve performance is, therefore, substantial, using, among other things, cogeneration systems (producing both electricity and heat), high efficiency lighting systems, or the recovery and energy use of processed residues and waste. Moreover, there is a political commitment in Europe to change.

Possible areas of intervention to reduce energy use include the following.

### Biotechnologies

Sectors in which the application of biotechnologies can lead to significant energy savings include those that require high temperature levels and have a high environmental impact such as the manufacture of plastics from hydrocarbons. Metabolic engineering in micro organisms and plants is now a mature sector using new chemical materials (modified amides, biopolymers, bioplastics) or catalyst enzymes that can lower energy inputs in processes like pulping, by exploiting free solar energy.

### Membrane separation processes

Membranes separation processes – for separating out different elements, such as drinking water from sea water - can replace high energy intensive separation processes in many industrial areas including the food processing, chemicals and paper industries. The technologies concerned include microfiltration, ultra filtration, nano filtration, inverse osmosis and electrodialysis. The membrane systems market is expanding rapidly at around 6% a year reflecting concerns about environmental sustainability and energy consumption.

### Combustion technology

Combustion processes are importance in the generation of electricity, but are also widely used in industry to generate steam and heat required for production processes. They account for a large part of the energy consumed in industry (in the US, an estimated 75% of all energy consumed by manufacturing) and there is consequently pressure to improve their efficiency, with government setting targets to reduce the energy they consume significantly by 2020 in the sectors of greatest energy intensity.

The long list of innovative technologies outlined above – some operational but with room for improvement, and some that are still at the research phase – illustrate their potential but also the scale of commitment required over coming years in order to make them operational. The challenge is not just to promote technological solutions as such, but to change industrial and consumer patterns of behaviour, to promote realistic and effective public policies, as well as to strengthen the commitment to strengthening education and training systems in order to ensure that theoretical possibilities are turned into realities.

# Part 3 – Emerging skills and competences

This part of the study addresses:

- the division of employment in the two sectors between different types of jobs – from management to unskilled labour - and the changes which have occurred in recent years;
- the levels of competence required to perform the different types of job, as reflected in the education attainment levels of the people employed in them and the way that this has changed over the recent past, which gives a guide to ongoing trends which are likely to affect the demand for labour in the coming years;
- the division of employment in the different jobs between people of different ages, which indicates the relative number of workers who are close to retirement and who, accordingly, may need to be replaced by younger people in the relatively near future;
- the division of employment between men and women and the extent to which the two sectors have made use of the skills of the latter, who have represented the main source of labour force growth in the EU for many years.

In this presentation, a number of limitations in the data and evidence have to be recognised, which arise primarily because of the lack of harmonisation or even standardisation with respect to skills and qualification categorisations between Member States. This reflects, not just the limitation of survey data, but the fact that work organisation arrangements, and their associated qualifications systems, are essentially nationally determined around long standing traditions reflecting, not only differences in the importance of particular sectors in individual Member States, but also differences in the ways in which key company objectives – ensuring an adequate supply of skills, or avoiding firms poaching from others – are addressed.

## Jobs performed within the electro-mechanical industry

Data from the EU Labour Force Survey (LFS) provide details of the occupations or jobs performed within the electro-mechanical sector. Though the survey collects information only from a relatively small sample of households, and therefore covers only a small proportion of those employed in the sector, it should, nevertheless, be large enough to indicate the broad division of employment between occupations within the sector in both the EU as a whole and in different countries.

However, the results of the analysis of the data presented below should be regarded as showing relative magnitudes rather than precise figures. This applies, in particular, to analyses of changes over time, which can be affected by the sample nature of the data.

The LFS data indicate that there are broad similarities in the division of employment between occupations with respect to the two parts of electro-mechanical engineering sector, but some significant differences in the division of employment between countries, especially between the EU15 countries and the new Member States.

### Manual workers

In 2007, manual workers accounted for some 57% of the total employed in the machinery and equipment sector in the EU as a whole, and around 59% of those employed in the electrical equipment sector. However, most of the jobs filled by manual workers in the machinery and equipment sector were for skilled workers - mechanics, fitters, electricians and so on (i.e. trades or craftsmen). This contrasts with the electrical equipment sector where many more of the manual workers are low skilled or semi-skilled (working on assembly lines, for example). This position is closer to that in manufacturing as a whole where, at EU level, there was a fairly even split between jobs for skilled workers, and jobs for less skilled workers (Table 12).

At the same time, there are major differences between EU15 countries and the new Member States in terms of the relative importance of jobs for manual workers in the two parts of the electro-mechanical sector, which reflects the difference in the activities carried out and, accordingly, the nature of the industry. In both parts of the sector, manual jobs comprised around 55% of the total in the EU15 in 2007, whereas in the new Member States, they accounted for 69% and 74%, respectively. In both cases, this was similar to the difference in manufacturing as a whole, where the figures were 58% and 73%.

Moreover, there are differences between Member States in the division between skilled and semi-skilled workers in machinery and equipment, again reflecting their different areas of specialisation and the types of skill associated with these. In both Germany and Finland, therefore, semi-skilled workers – predominantly those on production lines – accounted for only around 6-7% of total employment in the sector and skilled manual workers accounted for close to 40% or more, whereas in other countries, there was a much more even split between the two (in both the EU15 and among the new Member States). In all the other countries, therefore, the share of semi-skilled workers in employment was around 20% or higher, reflecting the greater importance of more routine tasks in the production process.

There is a similar difference between countries in the composition of manual workers in the electrical equipment industry. In Germany, semi-skilled workers represented only just over 10% of the workforce, in the UK, around 17% and in Finland, 22%, whereas in France and Italy, they represented around a third, in the Czech Republic, 35% and in the new Member States taken together, some 42%, and within this, machine operators, accounted for 40%. The latter figure emphasises the importance of production line work in the new Member States.

In addition, there are differences between EU15 countries and the new Member States in the composition of skilled manual workers. In machinery and equipment, the largest individual group in EU15 as a whole (as well as in most of the individual Member States) is mechanics and fitters, compared with the new Member States, where the most important group is tool-makers.

Among skilled manual workers in the electrical equipment sector, the main occupational group, not unexpectedly, are electricians (including specialists in electronics), which accounted for 18% of total employment in the industry in the EU15 and for as much as 23% in Germany.

### Professionals and technicians

In both sectors, the larger number of jobs for manual workers in the new Member States is reflected in a smaller number of jobs for professionals and technicians (i.e. for those with higher levels of education, often with university degrees or the equivalent) as well as for managers, compared with EU15 countries.

In both machinery and equipment and electrical equipment sectors, managers and professionals together made up some 35% of the total employed in EU15 countries in 2007. In the new Member States, by contrast, they accounted for 25% and 21%, respectively. (It should be noted that the distinction between managers and professionals varies between countries, according to the weight accorded to supervisory responsibilities as opposed to the profession as such, so that too much significance should not be attached to differences in the division between the two.)

**Table 12 Division of employment in electro-mechanical engineering by occupation, 2006**

*% of total employed in sector*

| | DE | FR | IT | FI | UK | CZ | EU15 | NMS | EU15 | NMS |
|---|---|---|---|---|---|---|---|---|---|---|
| | Machinery and equipment | | | | | | | | Manufacturing | |
| **Managers** | **6.2** | **6.2** | **4.5** | **10.8** | **19.0** | **4.8** | **7.5** | **4.8** | **7.7** | **4.9** |
| **Professionals+technicians** | **30.0** | **31.4** | **28.3** | **32.0** | **19.9** | **22.7** | **27.3** | **20.1** | **22.7** | **15.5** |
| Engineers | 20.2 | 24.8 | 14.6 | 20.1 | 11.2 | 11.7 | 16.8 | 11.6 | 10.2 | 6.2 |
| Computer specialists | 1.5 | 1.2 | 1.9 | 1.3 | 0.8 | 1.8 | 1.5 | 1.5 | 1.6 | 1.1 |
| **Other professionals** | **8.3** | **5.5** | **11.8** | **10.5** | **7.9** | **9.2** | **9.0** | **7.0** | **10.8** | **8.2** |
| Business, finance, sales | 4.1 | 3.6 | 4.3 | 5.7 | 5.1 | 2.6 | 4.4 | 2.3 | 3.9 | 2.4 |
| Aministrative+other | 4.2 | 1.9 | 7.5 | 4.9 | 2.8 | 6.6 | 4.6 | 4.7 | 6.9 | 5.8 |
| **Office workers** | **10.8** | **6.0** | **10.3** | **3.9** | **9.9** | **6.1** | **9.4** | **5.6** | **8.8** | **5.1** |
| **Sales+service workers** | **0.4** | **1.8** | **0.8** | **0.2** | **1.0** | **0.8** | **0.8** | **0.6** | **2.8** | **1.3** |
| **Skilled manual workers** | **42.0** | **31.0** | **29.2** | **43.0** | **22.6** | **41.7** | **34.7** | **45.6** | **28.9** | **37.8** |
| Metal moulders | 7.1 | 3.8 | 4.4 | 6.2 | 3.8 | 4.4 | 5.9 | 10.4 | 4.4 | 5.3 |
| Tool makers | 9.4 | 6.9 | 4.4 | 12.8 | 4.1 | 17.2 | 6.8 | 19.3 | 3.6 | 6.2 |
| Mechanics | 14.8 | 6.0 | 12.9 | 14.1 | 8.3 | 10.7 | 12.5 | 7.9 | 4.5 | 2.4 |
| Electricians+others | 10.6 | 14.2 | 7.6 | 9.8 | 6.3 | 9.4 | 9.4 | 8.0 | 16.3 | 23.8 |
| **Semi-skilled workers** | **6.4** | **20.9** | **21.1** | **6.9** | **20.6** | **21.3** | **15.2** | **20.4** | **21.7** | **27.8** |
| Machine operators | 5.5 | 19.1 | 20.2 | 6.5 | 17.8 | 18.9 | 13.9 | 18.5 | 18.9 | 24.0 |
| **Low skilled workers** | **4.2** | **2.7** | **5.7** | **3.2** | **7.1** | **2.8** | **5.0** | **2.9** | **7.5** | **7.7** |
| | Electrical equipment | | | | | | | | Manufacturing | |
| **Managers** | **5.4** | **6.0** | **2.7** | **7.0** | **21.3** | **3.1** | **7.4** | **3.3** | **7.7** | **4.9** |
| **Professionals+technicians** | **30.1** | **28.4** | **25.1** | **36.5** | **28.1** | **25.0** | **27.6** | **17.8** | **22.7** | **15.5** |
| Engineers | 20.7 | 21.1 | 11.3 | 22.1 | 15.2 | 12.0 | 16.5 | 9.6 | 10.2 | 6.2 |
| Computer specialists | 1.6 | 1.8 | 1.7 | 7.8 | 3.6 | 2.6 | 2.1 | 1.4 | 1.6 | 1.1 |
| **Other professionals** | **7.8** | **5.6** | **12.2** | **6.6** | **9.3** | **10.4** | **9.0** | **6.8** | **10.8** | **8.2** |
| Business, finance, sales | 3.5 | 3.0 | 5.4 | 4.6 | 8.7 | 3.2 | 4.8 | 1.7 | 3.9 | 2.4 |
| Aministrative+other | 4.3 | 2.6 | 6.8 | 2.0 | 0.6 | 7.2 | 4.2 | 5.0 | 6.9 | 5.8 |
| **Office workers** | **12.1** | **4.1** | **10.6** | **1.4** | **9.3** | **4.7** | **9.6** | **4.8** | **8.8** | **5.1** |
| **Sales+service workers** | **0.3** | **2.9** | **0.4** | **1.0** | **0.9** | **0.6** | **0.8** | **0.6** | **2.8** | **1.3** |
| **Skilled manual workers** | **35.2** | **20.5** | **22.6** | **29.8** | **20.3** | **29.9** | **26.1** | **24.9** | **28.9** | **37.8** |
| Metal moulders | 3.2 | 0.4 | 1.9 | 2.8 | 0.9 | 3.2 | 2.1 | 3.7 | 4.4 | 5.3 |
| Tool makers | 3.1 | 3.5 | 0.5 | 2.8 | 1.2 | 4.7 | 2.2 | 4.0 | 3.6 | 6.2 |
| Mechanics | 5.8 | 2.0 | 1.1 | 5.8 | 3.7 | 2.9 | 3.5 | 1.6 | 4.5 | 2.4 |
| Electricians+others | 23.1 | 14.6 | 19.1 | 18.5 | 14.5 | 19.1 | 18.3 | 15.6 | 16.3 | 23.8 |
| **Semi-skilled workers** | **10.3** | **34.2** | **33.5** | **22.4** | **16.9** | **35.0** | **22.9** | **41.9** | **21.7** | **27.8** |
| Machine operators | 9.9 | 32.7 | 32.2 | 22.4 | 16.3 | 34.3 | 22.0 | 40.1 | 18.9 | 24.0 |
| **Low skilled workers** | **6.5** | **3.9** | **5.2** | **1.8** | **3.1** | **1.8** | **5.7** | **6.6** | **7.5** | **7.7** |

There are, however, also differences between EU15 countries themselves, with managers and professionals accounting for well over 40% of total employment in both sub-sectors in Finland, but only around 33% in Italy in the case of machinery and equipment and 29% in the case of electrical equipment.

Within the professional category, engineers made up 17% of employment in both sub-sectors in the EU15, and over 20% in Germany, France and Finland, as compared with around 10-12% in the new Member States. Business, sales and financial professionals accounted for around 4-5%% of the total employed in the EU15, twice the proportion in the new Member States. Similarly, office workers and clerks of various kinds were almost twice as prevalent in the ‘former as in the latter.

It should be noted that despite the importance of computerisation in the two industries, computer specialists as such accounted for less than 2% of total employment in machinery and equipment in all Member States and for only around 2% of employment in most countries in electrical engineering. The major exception in the latter case is Finland – and to a lesser extent the UK – where computer specialists made up 8% of the total workforce in the industry in 2007 (around 3.5% in the UK). These figures, it should be emphasised, do not reflect the importance of computer skills in the two industries since such skills are a necessary part of the competences required in other occupational groups, in engineers in particular but also, increasingly, in skilled manual workers. The high figure in Finland, however, is indicative of the significance of such skills in the industry in this country.

## Recent changes in occupational structure

The changes that have occurred in the occupational structure of employment across the EU show both common features and differences as between the two parts of the electro-mechanical sector.

In the machinery and equipment part of the sector, there was a common tendency for the share of employment of managers and professionals to increase in EU15 countries between 1999-2000 and 2006-2007 (Table 13)[10]. This was not the case in the new Member States, where their share seems to have remained unchanged. This difference especially apparent for engineers, whose share of total employment increased in EU15 countries, in some cases markedly, but declined slightly in the new Member States (in contrast to the experience in the manufacturing sector as a whole). The share of business, sales and finance professionals also increased across the EU15 and, in this case, in the new Member States as well – in the latter compensated by a decline in the share of administrative and other professionals (such as human resource professionals).

The counterpart of the increase for managers and professionals was a widespread reduction in the share of employment of office workers and, more especially, of skilled manual workers. Among the latter, however, there was a general increase in the relative number of electricians and skilled electronics workers, though not, on average at least, in the new Member States.

The most pronounced tendency, however, was the increase in the relative number of semi-skilled manual workers, machine operators, in particular, in the new Member States, their share of the total employed in the industry rising by almost percentage points over the period, in stark contrast to most EU15 countries, where their share fell.

These tendencies are also apparent in the electrical equipment part of the sector. In this case, there was an increase on average over the period in the proportion of jobs for managers and professionals in the new Member States as well as the EU15. In the latter, however, Germany represents a marked exception to this tendency, the share of jobs for professionals declining significantly. This was equally the case for jobs for engineers, the number of which fell by 1 percentage point whereas in other countries, it increased. Nevertheless, the relative number of jobs for engineers in the industry in Germany in 2007 was still above the EU15 average.

The decline in the relative number of engineers and other professional in Germany was mirrored by an increase in the share of skilled manual workers, especially mechanics and electricians. There was a similarly large increase in the share of skilled workers in Finland and, to a lesser extent, France, where in both cases, this was concentrated even more on electricians.

[10] It should be noted that an average of the two years has been taken in order to allow for year-to-year fluctuations in the LFS data because of its sample survey nature.

In stark contrast, there was a sharp reduction in the share of skilled manual workers in the new Member States (by almost 9 percentage points). This was mirrored by an even bigger increase in the share of semi-skilled workers, and machine operators in particular, which rose by some 12 percentage points on average.

**Table 13 Change in division of employment in the electro-mechanical sector between 1999-2000 and 2005-2006**

*Percentage point change in division*

| | DE | FR | IT | FI | UK | CZ | EU15 | NMS | EU15 | NMS |
|---|---|---|---|---|---|---|---|---|---|---|
| | Machinery and equipment | | | | | | | | Manufacturing | |
| **Managers** | **0.4** | **0.6** | **0.8** | **1.0** | **0.0** | **0.5** | **-0.1** | **0.5** | **1.0** | **0.9** |
| **Professionals+technicians** | **1.9** | **2.4** | **11.6** | **5.9** | **2.1** | **-0.2** | **4.0** | **-0.5** | **4.2** | **2.2** |
| Engineers | 0.4 | 3.0 | 5.8 | 3.2 | 1.7 | -0.9 | 1.7 | -0.2 | 1.8 | 0.8 |
| Computer specialists | 0.3 | -0.7 | 0.7 | 0.0 | -0.2 | 0.4 | 0.2 | 0.6 | 0.3 | 0.6 |
| **Other professionals** | **1.3** | **0.0** | **5.1** | **2.7** | **0.6** | **0.3** | **2.0** | **-0.8** | **2.1** | **0.8** |
| Business, finance, sales | 1.4 | 0.1 | 0.7 | 1.3 | 0.1 | 1.0 | 0.9 | 0.5 | 0.6 | 0.6 |
| Aministrative+other | -0.1 | -0.1 | 4.3 | 1.3 | 0.4 | -0.7 | 1.2 | -1.3 | 1.5 | 0.3 |
| **Office workers** | **0.5** | **-3.3** | **-5.0** | **-1.4** | **-1.4** | **-2.2** | **-1.3** | **-1.0** | **-1.0** | **0.0** |
| **Sales+service workers** | **-0.1** | **0.9** | **-0.3** | **0.1** | **0.1** | **-0.8** | **0.1** | **-0.5** | **0.1** | **-0.3** |
| **Skilled manual workers** | **-1.5** | **-3.0** | **-7.2** | **-4.8** | **-4.1** | **2.2** | **-3.0** | **-2.0** | **-3.1** | **-1.1** |
| Metal moulders | -0.7 | -0.6 | -3.0 | -3.3 | -0.9 | -0.8 | -0.8 | 4.2 | -0.3 | 2.5 |
| Tool makers | -0.6 | -3.0 | 0.9 | -3.1 | -1.1 | -2.6 | -0.9 | -8.1 | -0.1 | -2.0 |
| Mechanics | -0.5 | -3.2 | -6.2 | -0.2 | -2.8 | 4.6 | -2.2 | 1.9 | -0.5 | 0.1 |
| Electricians+others | 0.3 | 3.9 | 1.1 | 1.8 | 0.7 | 1.0 | 0.9 | 0.0 | -2.2 | -1.7 |
| **Semi-skilled workers** | **-1.2** | **2.4** | **-2.0** | **-0.4** | **-0.1** | **2.4** | **-0.4** | **5.0** | **-1.6** | **9.7** |
| Machine operators | -0.9 | 1.6 | -1.9 | 0.0 | -0.5 | 2.6 | -0.4 | 5.7 | -1.9 | 9.4 |
| **Low skilled workers** | **-0.1** | **0.0** | **2.1** | **-0.5** | **3.4** | **-1.9** | **0.7** | **-1.4** | **0.5** | **-1.9** |
| | Electrical equipment | | | | | | | | Manufacturing | |
| **Managers** | **0.6** | **3.2** | **0.1** | **-3.8** | **4.5** | **-1.6** | **1.0** | **-0.8** | **1.0** | **0.9** |
| **Professionals+technicians** | **-4.0** | **1.7** | **6.3** | **4.5** | **4.5** | **2.7** | **1.1** | **1.3** | **4.2** | **2.2** |
| Engineers | -1.1 | 1.6 | 1.3 | 1.2 | 0.1 | 1.2 | -0.1 | 1.3 | 1.8 | 0.8 |
| Computer specialists | -1.1 | -0.1 | 1.7 | 3.6 | 1.2 | 1.2 | 0.3 | 0.3 | 0.3 | 0.6 |
| **Other professionals** | **-1.8** | **0.2** | **3.4** | **-0.3** | **3.2** | **0.3** | **0.9** | **-0.4** | **2.1** | **0.8** |
| Business, finance, sales | 0.1 | -0.2 | 0.8 | -0.5 | 3.8 | 1.0 | 0.9 | -0.2 | 0.6 | 0.6 |
| Aministrative+other | -1.9 | 0.4 | 2.6 | 0.2 | -0.6 | -0.7 | 0.0 | -0.2 | 1.5 | 0.3 |
| **Office workers** | **-0.2** | **-4.6** | **-2.3** | **-3.5** | **-1.3** | **0.3** | **-1.2** | **-0.4** | **-1.0** | **0.0** |
| **Sales+service workers** | **-0.2** | **1.6** | **-0.9** | **0.8** | **0.5** | **-0.3** | **0.1** | **0.3** | **0.1** | **-0.3** |
| **Skilled manual workers** | **4.3** | **3.1** | **-5.6** | **7.7** | **-0.3** | **-0.9** | **1.5** | **-8.7** | **-3.1** | **-1.1** |
| Metal moulders | 0.7 | -0.4 | -1.0 | -1.2 | -0.3 | 1.2 | 0.0 | 1.3 | -0.3 | 2.5 |
| Tool makers | 0.0 | 0.5 | 0.3 | 0.6 | 0.5 | -0.7 | 0.0 | -4.0 | -0.1 | -2.0 |
| Mechanics | 2.2 | -0.4 | -2.4 | 2.5 | -0.3 | 1.6 | 0.4 | -0.3 | -0.5 | 0.1 |
| Electricians+others | 1.4 | 3.4 | -2.4 | 5.8 | -0.1 | -3.0 | 1.0 | -5.8 | -2.2 | -1.7 |
| **Semi-skilled workers** | **-0.5** | **-5.1** | **0.5** | **-5.0** | **-8.1** | **11.5** | **-2.3** | **11.8** | **-1.6** | **9.7** |
| Machine operators | -0.2 | -5.2 | -0.1 | -4.7 | -8.4 | 11.8 | -2.4 | 12.2 | -1.9 | 9.4 |
| **Low skilled workers** | **0.1** | **0.1** | **1.8** | **-0.6** | **0.2** | **-11.5** | **-0.1** | **-3.5** | **0.5** | **-1.9** |

These very different tendencies reflect the shift of manufacture of a number of electrical engineering products from the EU15 countries to the new Member States, though more particularly of parts of the production process which are more labour intensive, involving the employment of less skilled workers, with a counterpart concentration of production in the EU15 countries on those parts of production which require higher skilled workers, where for example precision in engineering is of key importance.

Closer examination of the data suggests that this tendency has been a feature of most sub-sectors of the electrical equipment, though not in the case of the manufacture of lighting equipment and lamps, where there has also been a significant shift in production towards the new Member States, but where the share of skilled manual workers, in contrast, increased rather than declined.

It should be noted, however, that the same tendency is much less evident in machinery and equipment, where the employment data indicate much less of a shift in the lower skilled jobs from the EU15 to the new Member States, implying that up to now at least, there has been less scope for this to occur.

## Summary of trends in occupational structure

The trends in the structure of jobs in the two parts of the electro-mechanical sector can be summarised in graphical form, starting with the machinery and equipment industry (Figures 9-110)

**Figure 9**

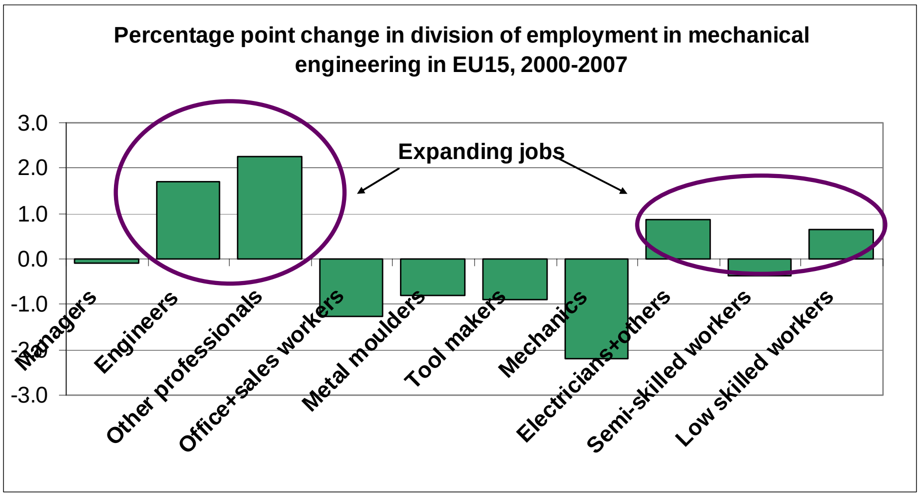
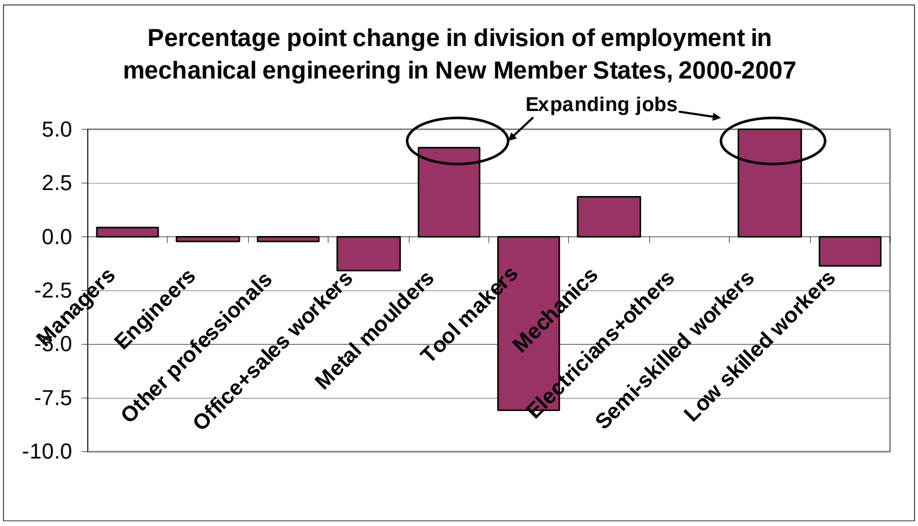



**Figure 10**



The major trends in the structure of jobs over the period 2000-2007 were, therefore:

- In the EU15, an expansion in engineers and other professionals as well as in electricians and low skilled workers, coupled with an a reduction in jobs requiring traditional skills – for tool makers, metal moulders and mechanics – as well as in jobs for office staff
- In the new Member States, an expansion in demand for metal moulder and mechanics among skilled workers but a reduction for other skills, as well as for semi-skilled operators, especially for machine operators, coupled with a slight reduction in demand for managers and professionals and a bigger reduction for tool-makers (implying an overall decline in jobs for skilled manual workers)

For electrical equipment manufactures, the trends can also be summarised graphically:

**Figure 11**

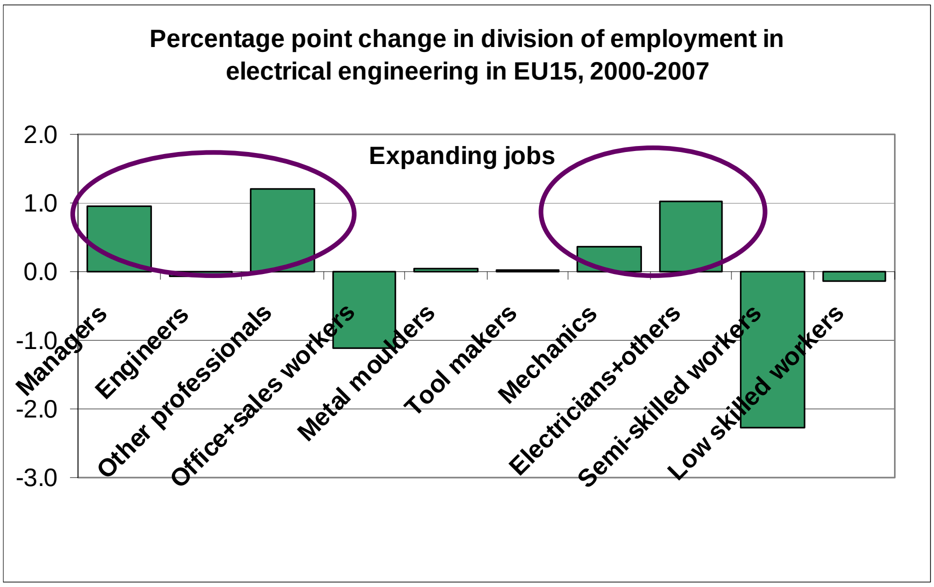
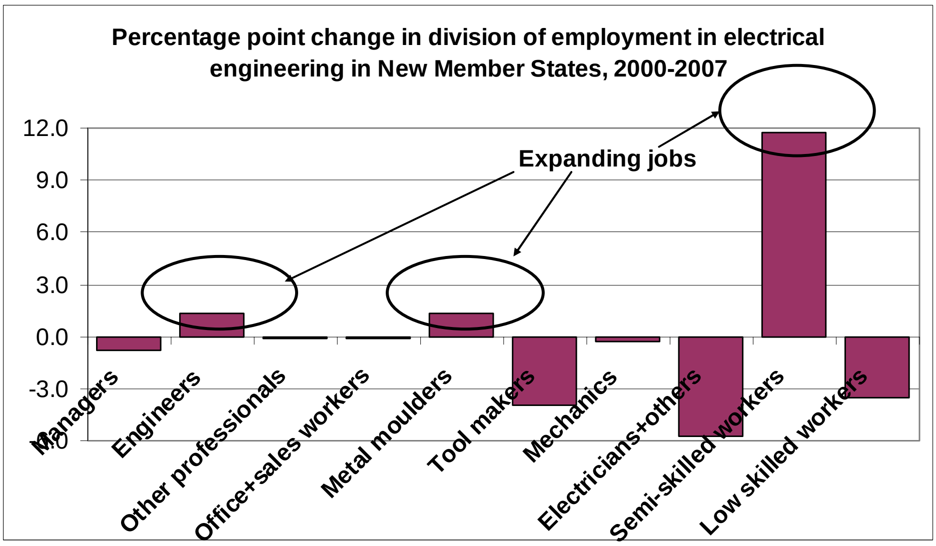



**Figure 12**



The differences between EU 15 and EU 12 for the same period were even greater with respect to the electrical equipment industry:

- In the EU15, expansion of jobs for managers and other professionals, but also for electricians and, to a lesser extent mechanics, coupled with a decline in those for offices workers and, above all, for machine operators
- In the new Member States, some growth in demand for engineers as well as metal moulders, but above all for semi-skilled workers – i.e. for machine operators – combined with a substantial reduction in jobs for skilled workers.

The main underlying factors in the EU15, given the discussion above on drivers, would appear to be changes in the production process – i.e. in technology – coupled with organisational changes: in business structure, which, in the machinery and equipment industry, in particular, have reduced the demand for traditional manufacturing skills and increased the demand for managers and other professionals, though also for electricians given the growing computerisation and automation of production. At the same time, jobs for office workers, again reflecting computerisation, have also declined.

Changes in the division of employment in the new Member States seem to have been primarily determined by changes in specialisation following enlargement and by comparative advantage. Areas of production which are relatively labour intensive have, therefore, seen a substantial growth of jobs. This is most evident, as noted, above, in the electrical equipment industry.

## The implications for education and skill levels

The above trends have clear implications for the education and skill levels of the work force in the electro-mechanical sector. A shift towards jobs for managers and professionals in itself has increased the demand for people with relatively high levels of education, while the shift away from manual workers, and semi-skilled workers in particular, has reduced the demand for people with vocational training qualifications. At the same time, there has been an increase in education levels within occupational groups, so reinforcing these tendencies.

The scale of the overall effect, however, varies across countries. This is evident in the differences which exist in the education levels of people performing particular jobs across the EU. In the case of engineers, therefore, while 65-70% of those employed in the sector in this capacity have university degrees of the equivalent in Germany and Finland, in Italy, the figures is only 15% and in the Czech Republic, 24% - though in other new Member States, it is higher (averaging 57%) (Figure 13).

Similarly, for other professionals, the proportion with tertiary education in the EU15 varies from 66% in Finland and 53% in the UK to 19% in Italy, while in the new Member States, it averaged 57%, though only 28%  the Czech Republic (Figure 14).

**Figure 13**

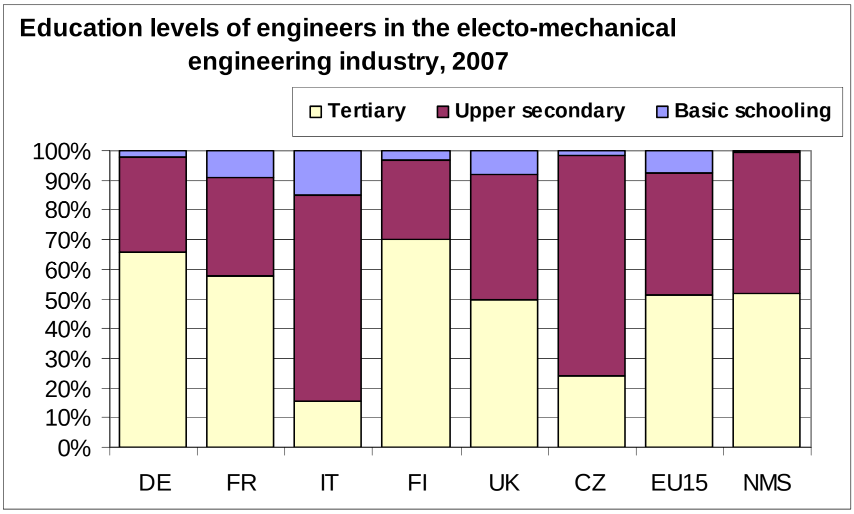
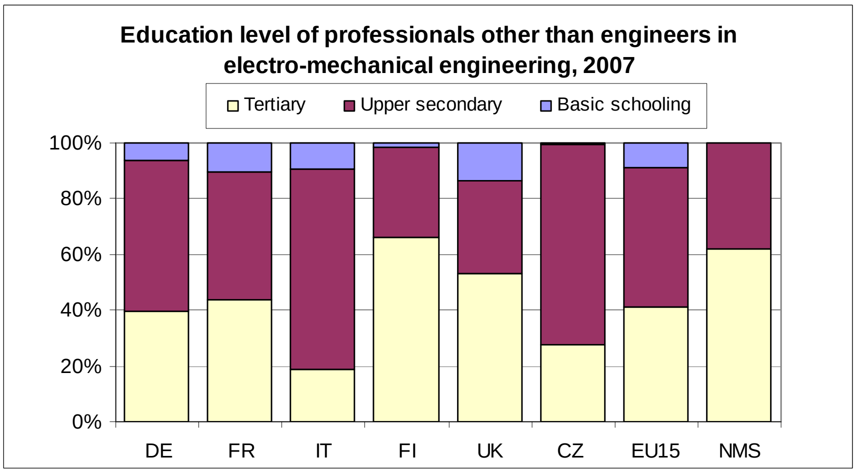
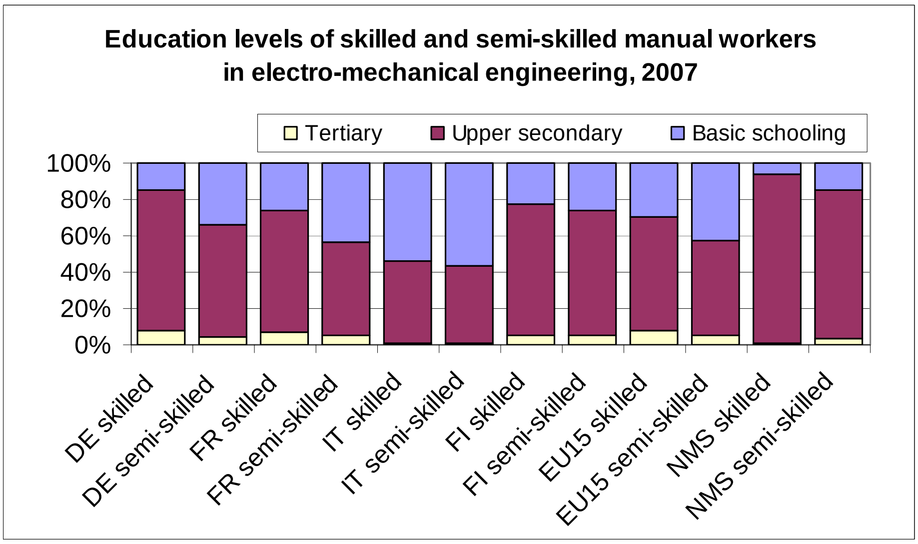



**Figure 14**




A similar variation exists for skilled and semi-skilled manual workers, though here the difference between countries is in terms of the proportion with upper secondary education (typically a vocational training qualification) and those with no educational qualification beyond basic schooling. Whereas in all countries, the proportion of skilled workers with upper secondary qualifications is greater than for semi-skilled workers, the difference is relatively small in Finland as well as Italy. Moreover, there are large differences across countries – especially between Finland and Italy – in the overall proportion of both groups of worker with at least upper secondary education (Figure 15).

**Figure 15**




The change within occupational groups has also tended to vary across countries, though there are common features. In particular, the proportion of workers with no qualifications beyond basic schooling has declined in recent years (specifically 2001-2007) in all occupations in all, or nearly all, countries, in some cases, markedly (table 14). In addition, there has been a general tendency for the share of those employed in professional jobs, other than for engineers, with tertiary education to increase, though for engineers employed in the sector in the EU15, in contrast to trends in manufacturing as a whole, there has been a decline in the share with tertiary education. This contrasts with the substantial increase which has occurred in the new Member States (Figure 16)

**Table 14 Changes in division of employment by education level in electro-mechanical engineering, 2001-2007**

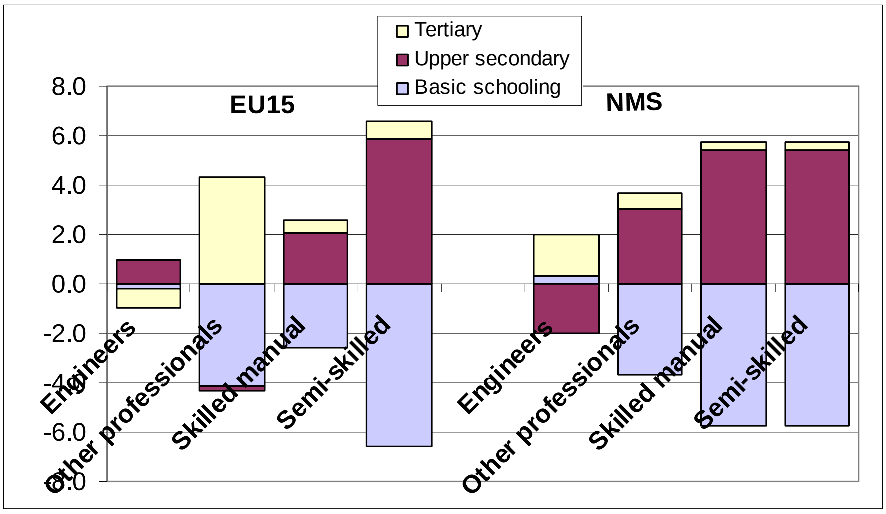
*Percentage point change*

| | | Electro-mechanical industry | | | | | | | | Manufacturing | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **DE** | **FR** | **IT** | **FI** | **UK** | **CZ** | **EU15** | **NMS** | **EU15** | **NMS** |
| **Managers** | **1. Low** | **-1.6** | **0.7** | **-2.9** | **-3.5** | **0.0** | **-1.8** | **-1.9** | **-2.3** | **-1.7** | **-0.7** |
| | **2. Medium** | **0.8** | **1.6** | **8.5** | **1.5** | **-4.6** | **7.5** | **1.1** | **-0.9** | **-0.9** | **-1.8** |
| | **3. High** | **0.8** | **-2.3** | **-5.5** | **2.1** | **4.5** | **-5.7** | **0.8** | **3.2** | **2.6** | **2.5** |
| **Professionals+** | **1. Low** | **-1.8** | **0.4** | **-3.9** | **-3.5** | **0.2** | **1.0** | **-1.8** | **0.2** | **-1.6** | **-0.5** |
| **technicians** | **2. Medium** | **0.7** | **-6.2** | **5.0** | **4.2** | **1.4** | **-1.6** | **0.6** | **-3.2** | **-1.2** | **-5.0** |
| | **3. High** | **1.1** | **5.8** | **-1.1** | **-0.7** | **-1.6** | **0.5** | **1.2** | **3.1** | **2.9** | **5.5** |
| Engineers | 1. Low | -1.1 | 0.6 | 0.7 | -2.8 | 0.8 | 1.2 | -0.2 | -0.2 | -0.2 | -0.6 |
| | 2. Medium | 3.3 | -10.4 | 3.4 | 5.8 | 5.5 | 0.0 | 1.0 | -3.2 | -1.5 | -2.5 |
| | 3. High | -2.2 | 9.9 | -4.1 | -2.9 | -6.3 | -1.1 | -0.8 | 4.5 | 1.7 | 3.1 |
| **Other** | **1. Low** | **-3.1** | **0.0** | **-8.2** | **-5.2** | **-1.0** | **0.7** | **-4.1** | **0.3** | **-2.5** | **-0.8** |
| **professionals** | **2. Medium** | **-4.2** | **4.3** | **6.1** | **4.0** | **-2.9** | **-3.2** | **-0.2** | **-2.0** | **-1.4** | **-7.2** |
| | **3. High** | **7.3** | **-4.4** | **2.1** | **1.2** | **3.9** | **2.6** | **4.3** | **1.7** | **3.9** | **8.0** |
| **Skilled manual** | **1. Low** | **-0.5** | **0.9** | **-8.1** | **1.5** | **-0.6** | **-3.3** | **-2.6** | **-3.7** | **-4.2** | **-3.5** |
| | **2. Medium** | **2.4** | **-3.5** | **8.3** | **-3.8** | **-2.2** | **3.3** | **2.1** | **3.0** | **2.9** | **2.9** |
| | **3. High** | **-1.9** | **2.6** | **-0.2** | **2.3** | **2.7** | **0.0** | **0.5** | **0.7** | **1.3** | **0.7** |
| **Semi-skilled** | **1. Low** | **-2.2** | **-3.7** | **-8.6** | **-11.4** | **-17.1** | **-6.6** | **-6.6** | **-5.7** | **-7.7** | **-6.1** |
| | **2. Medium** | **2.9** | **3.5** | **8.5** | **11.3** | **15.3** | **6.8** | **5.9** | **5.4** | **6.7** | **5.8** |
| | **3. High** | **-0.7** | **0.2** | **0.1** | **0.1** | **1.8** | **-0.1** | **0.7** | **0.3** | **1.0** | **0.4** |

*Note: The changes give an indication of the changes over this period but because of the sample nature of the data, they should not be regarded as being precise. No data are shown for engineers and computer specialists separately because of reliability problems.*

**Figure 16**

**Percentage point change in the division of employment between education levels in the electro-mechanical engineering sector, 2001-2007**

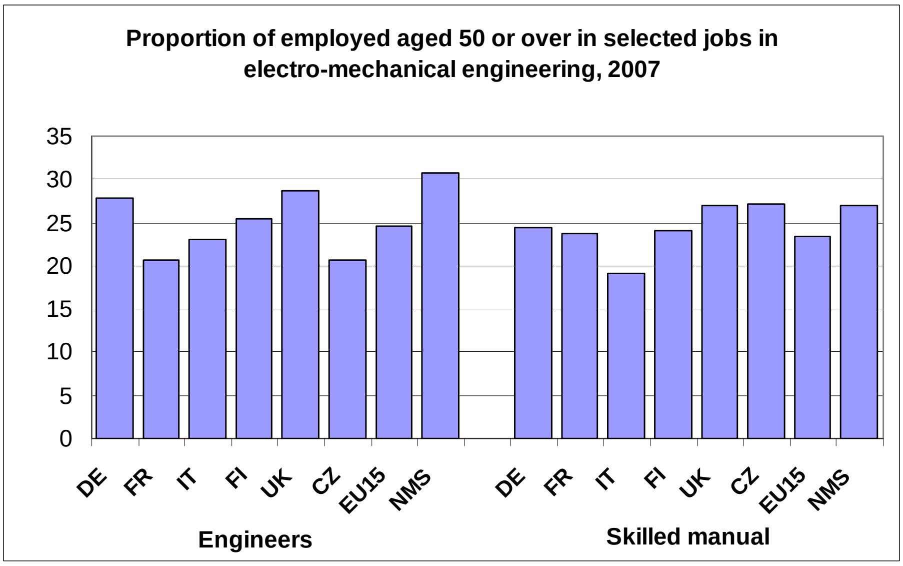



## Age of workforce

A relatively large number of those employed in skilled manual jobs in electro-mechanical engineering across the EU are aged 50 or over, which implies that the industry is likely to lose a significant proportion of key workers in the medium and longer term as the people concerned retire. The same is true of engineers in many parts of the EU. Both groups of worker will, accordingly, need to be replaced so long as the jobs they are doing remain (the prospects of which are considered below), which could give rise to recruitment problems in future years, the scale of which is itself likely to vary with the prospects for the industry.

In the EU15 as a whole, therefore, around 25% of engineers in the industry are aged 50 or over (Figure 17). In the new Member States, however, the figure is over 30%.

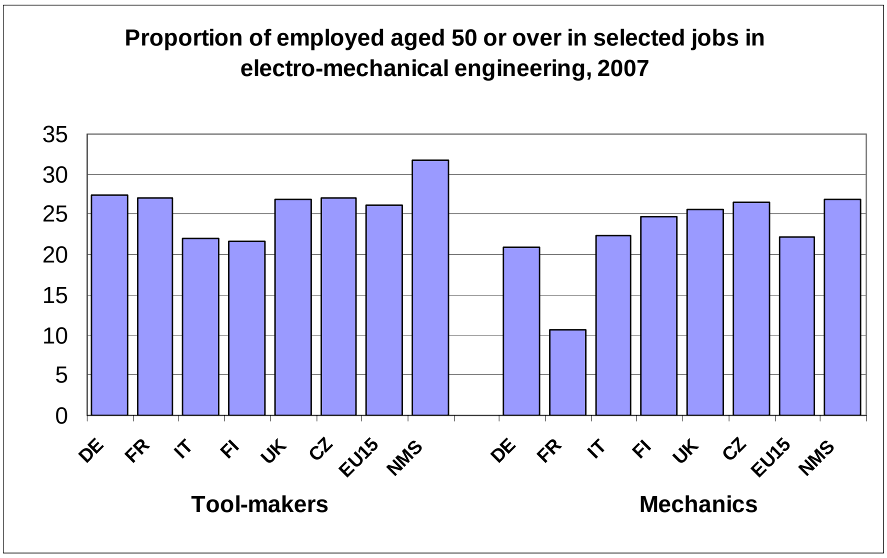
**Figure 17**



The proportion varies across countries being just under 30% in both Germany and the UK. Among skilled manual workers taken together, the proportions tended to be slightly smaller, though it is still the case that in the EU15 as a whole, some 23% of people in these jobs in the industry are aged 50 or over, with the proportion again being relatively large in Germany and the UK (25-27%). In the new Member States, the figure is also relatively high, with well over a quarter of such workers aged 50 or over.

Among skilled workers, moreover, the proportion of those employed who are 50 or over is especially high in particular kinds of job. This is the case especially for tool-makers, some 26% of whom are in this age group in the EU15 – and 27% in Germany, France and the UK – while in the new Member States, the figure is as high as 32% (Figure 18).

**Figure 18**




The proportion of older workers is less in the case of mechanics, though the figure is still around 25-26 in Finland and the UIK and 27% in the new Member States taken together. While the figure is also lower for electricians, which is the main type of job likely to expand, the relatively number of workers aged 50 and over is, nevertheless, around 27% in the UK and 28% in France.

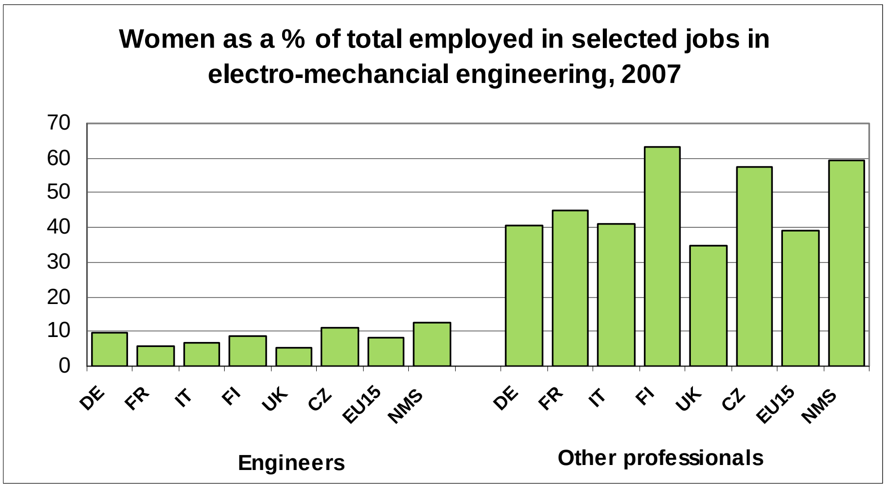
## Gender structure of the workforce

Men outnumber women employed in the electro-mechanical industry in the EU15 by 4 to 1. A wide gender imbalance is not unusual in manufacturing industry in the EU15 in which relatively few women work in skilled or semi-skilled manual jobs, though more in the latter than the former, especially on production or assembly lines where tasks do not involve heavy labour and are extremely repetitive. The extent of the imbalance in the electro-mechanical industry in the EU15, however, is wider than in the rest of manufacturing (only 20% of the total employed were women in 2007 as opposed to around 30% in the rest of manufacturing.

In the new Member States, the imbalance is less extreme, with women making up around 32% of all those employed in the industry (around 10 percentage points less than in the rest of manufacturing).

In both groups of country, the imbalance is concentrated among skilled manual workers and engineers, though it is also the case that only around 15% of managers in the industry are women and this applies to the new Member States as well as the EU15. Women, therefore, accounted for only 8% of the engineers employed in the electro-mechanical industry in the EU15 in 2007, with the proportion being below 10% in most Member States. In the new Member States, the proportion was only slightly higher (12%) (Figure 19).

**Figure 19**




This contrasts with the gender composition of other professionals, many more jobs for whom were filled by women. Nevertheless, there is still a marked disparity between the EU15 countries, Finland apart (including in the EU15 countries not shown in the figure) and the new Member States, where women on average made up around 60% of the total working in such jobs.

The gender imbalance is even more extreme in the case of skilled manual workers, where women accounted for just 6% of the total employed in the EU15 and only 3% in the UK (Figure 20). In the new Member States, the figure was higher, but it was still the case that there were some 6 times as many men employed in such jobs as women.

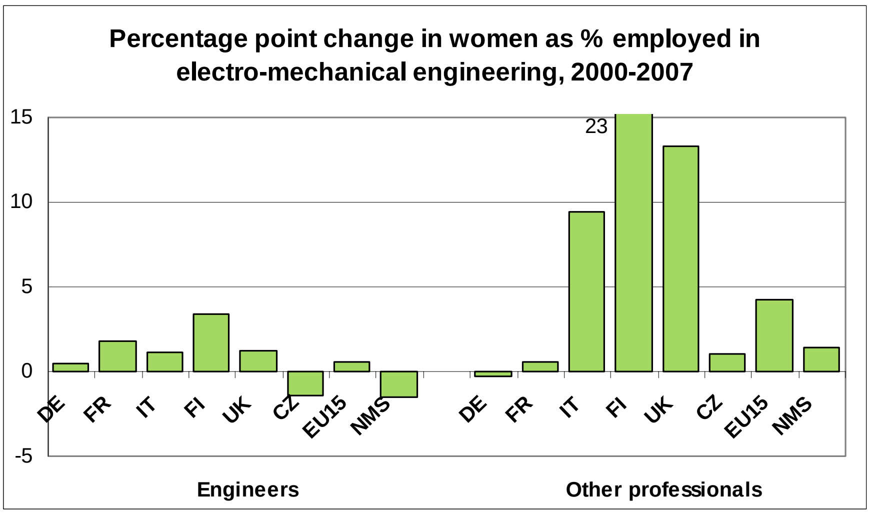
Women, on the other hand, filled a larger share of the jobs for semi-skilled workers in the electro-mechanical industry – some 25% in the EU15 as a whole in 2007 and around 29-30% in Germany and Finland. This, however, was only around half the proportion in the new Member States, where women made up around 50% of those employed as machine operators.

**Figure 20**


There is only limited evidence that the proportion of women filling the more technical jobs has tended to increase over recent years. In the EU15, therefore, the share of women among engineers in the industry in the EU15 increased by only 1 percentage point between 1999-2000 and 2006-2007 and only in three countries – Finland (shown in the figure), Spain and Sweden (not shown in the figure) – did it increase by more than 2 percentage points. In the new Member States, the proportion declined by 2 percentage points (Figure 21).

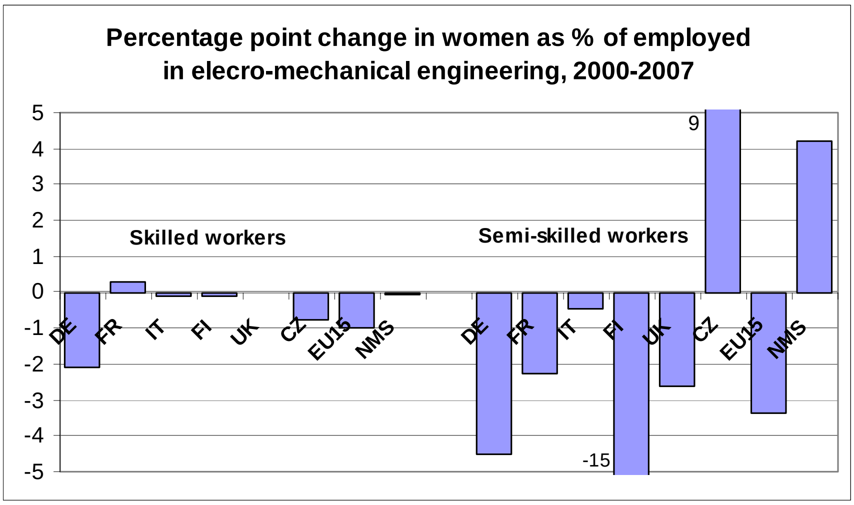
In the case of other professionals, on the other hand, the relative number of jobs filled by women increased, especially in the EU 15 (by around 4 percentage points overall).In Italy, the UK and, above all, in Finland, the proportion increased by around 9 percentage points or more. The proportion filled by women also increased in the new Member States, if only slightly, despite the relatively figure it had already reached. In Germany, however, the proportion declined.

**Figure 21**



There is even less evidence of any correction in the gender imbalance in jobs for skilled manual workers in the industry over recent years. In nearly all EU15 countries as well as in the new Member States, the proportion of such jobs filled by women declined or remained unchanged (Figure 22).

**Figure 22**




The same is the case for semi-skilled workers employed mainly as machine operators in the EU15. In marked contrast, in the new Member States, the proportion increased by an average of 4 percentage points. In consequence, not only has there been a relative expansion of jobs for machine operators in the new Member States but many of the net additional jobs created seem to have been filled by women.

## Skill shortages - a particular challenge for the sector

Because the electro-mechanical engineering sector is particularly sensitive to fluctuations in European and global growth, it is especially prone to periodic problems of skill shortage when demand for its products increases relatively rapidly during periods of upturn. These problems reinforce the longer-term shortages of suitably qualified people to perform particular jobs, especially those involving computerisation. The problems, however, not only vary in scale across countries but the responses to them also vary, reflecting in large part the different national systems of education and training, of career structures and the qualifications needed to do particular jobs. The qualifications concerned are not only formal but also informal, in the shape of experience and competences acquired on the job through learning by doing.

At least part of the causes and nature of skill shortages, as reported by employers in the industry in different EU countries, seem to be structural in the sense of the education and training system in different countries failing to produce people with the skills and competences required by industry. The content of vocational training programmes, in particular, but also university degree courses do not, therefore, always match the precise requirements of employers.

This partly reflects technological advance in the industry and, in particular, the increasing and widening use of computerisation in most activities, not only in the production process as such but also in ancillary activities which are becoming increasingly important with the growing interaction between manufacturers and customers. The need, accordingly, is for skilled workers as well as professional engineers to acquire as a core part of their training a level of computer skills which is tending to increase significantly over time.

This applies, moreover, not only to the young people being recruited from college or university or completing their apprenticeships but also to the existing work force who need to be able to extend and adapt their skills over time as technology advances and techniques of production change with it.

The policy response to this need differs across countries in line with both the education and training system in place and the attitude of companies to the provision of training, which is coloured by what they are accustomed to doing and the competences they expect newly qualified recruits to possess. The perceived division of responsibility for training and for ensuring that people have the requisite skills to perform particular jobs, and consequently the type of training provided by employers, on the one hand, and the education system, on the other, therefore, varies markedly across the EU.

At one extreme, employers in the UK both need and expect to provide, or at least arrange for, extensive training to the young people they take on – who may have studied a range of different subjects. At the other extreme, German employers, recruiting people who are likely to have had many more years of formal education and training expect to provide only limited training specific to the precise task which needs to be performed.

Moreover, the involvement of the social partners in training varies equally widely across the EU, from Sweden and other Nordic countries where trade unions and employer organisations are closely involved in the design as well as the delivery of training programmes to countries where involvement is minimal.

# Part 4 – Scenarios and implications for employment trends

## Background

Scenarios for the future of the electro-mechanical sector depend on the combined effects of three sets of forces:

- economic developments in the widest sense;
- technological advances and their application;
- organisational changes within and between firms.

To these three can be added a fourth factor, which is the policy adopted and pursued by governments across Europe, which may take the form not only of responding to developments in these three areas, and either facilitating or preventing change from taking place, but also of initiating change or of attempting to shift the path of a development in a particular direction. Imposing restrictions on environmentally damaging activities fall into the last category, as does support for the development of renewable sources of energy, though both can equally be regarded as a means of promoting technological advance. Equally, removing restrictions on internal trade and liberalising markets for energy supply also fall into the last category.

The impact on employment will depend on the balance struck between output growth on the one hand, and productivity growth on the other, with potential implications for the competitiveness of the sector, and ultimately for the scale and structure of demand for different workforce skills and competences by different firms in different countries.

### Impact of economic factors

Both parts of the electro-mechanical sector are primarily involved in the manufacture of capital or investment goods, demand for which tends to fluctuate significantly more than output in general. Moreover, since the enlargement of the EU, substantial parts of production of some goods and of particular activities have shifted to the new Member States – some involving supply chain fragmentation or rational division of this, some the movement of large parts of entire sub-sectors of the industry – as well as outside the EU to lower cost locations. As noted above, this is especially the case in the electrical equipment part of the sector, where there seems, up to now at least, more scope for relocating the more labour-intensive parts of production,

On the positive side, however, the growth of developing Asian economies as well as, if to a lesser extent, economies in Latin America, in has led to strong demand for the products of the sector. Both parts off the sector have been successful in the current era of globalisation, running a sizable surplus on trade with the rest of the world, and one that has widened over recent years.

Currently, the EU accounts for 33% of world exports of machinery and equipment, a considerably larger proportion than the US (18%) and Japan (13%), and for 18% of world exports of electrical machinery and apparatus, again more than the US (13%) and Japan (12%). Together the two sub-sectors account for 21% of total EU exports of goods (mechanical 16%, electrical 5%)

Regulation has also had an important impact on the conduct of both industries, in terms of both European and international standards. However, liberalising energy markets and the recent opening up of the internal market for energy equipment supply is a major factor affecting future developments in the sector relative to the past.

### Impact of organisational factors

Over the long-term, both industries have moved from craft-based production (begun in Europe – notably Germany and the UK) through mass production addressing mass markets (initiated in the US) to a much more sophisticated interaction between suppliers and consumers – just-in-time stock control, total quality and quality circles, learn and flexible production (initiated in Japan).

All three methods of working and work organisation still exist, meeting specific market needs. However, there has been, throughout the reference period, a general convergence in the way production is organised with the successful integration of modern, Japanese-derived, management techniques with innovative hybrid, computer-related, technologies, resulting in increasing flexibility, changing economies of scale, rising standards of precision, and the adoption of an increasing range of new materials.

Such trends can be expected to continue at much the same pace as in the past. There is the possibility, however, that increased competitive pressure – due to recession or the strengthening performance of global competitors in China or elsewhere in Asia and pther parts of the world – could lead to an acceleration in this process, along the lines outlined above (in the section on drivers of change). This could have a number of different effects. In particular, it is likely to stimulate the search for ways of reducing costs which might lead not only to the (earlier) adoption of more automated methods of production but also perhaps to more flexible methods of working as well as moves to limit improvements in the terms and conditions of employment. It could equally lead to a larger proportion of production being relocated to lower wage countries. At the same time, through this and other changes, it could tilt the employment structure even more in favour of highly qualified personnel. More generally, it is likely to result in increased productivity and, accordingly, a smaller work force.

### Impact of technological factors

The development of hybrid technologies, linking both traditional and new knowledge to computer usage, has been transforming the way much of the sector (especially the mechanical part) has developed in recent years.

Mechatronics is an example of such a fusion of technologies – electronics, mechanics and computer software – resulting in numerically controlled machine tools and industrial robots as well as intelligent systems for controlling processes (of production and distribution). In addition to increased efficiency and lower costs, it also makes it possible to better integrate design and manufacture and, therefore, to cater more immediately and flexibly for customer needs.

## Building scenarios

Future scenarios for the electro-mechanical engineering sector need to take account of the impact of the most important underlying drivers of change within these different domains – economic, technological and organisational – as well as political, and to assess whether current trends in the way these factors are developing are likely to continue or whether, on the contrary, they are likely to change and if so in what direction and with what consequences for employment and skill needs in the sector.

In this particular industry more than others, however, the scenarios also need to take account of the relationship between the growth of value-added in the two sub-sectors and that of the economy as a whole and equally important of productivity developments which affect the way that employment responds to changes in output.

These aspects are of critical importance when thinking about potential future developments in the industry in the sense that it is difficult to do this coherently without, first, having an overall picture of developments in the EU economy as a whole and an understanding of how developments in the industry fit into this. Secondly, it is difficult to consider prospective employment developments in the industry without relating these to how the output of the industry is likely to grow, or contract.

Although the future will not necessarily resemble the past in terms of such relationships, it is as well to have in mind the form they have taken in recent years as a basis of thinking about what might happen in the future, and about what needs to happen for the future to be different from the past. Consideration of past trends is, therefore, an essential starting-point for examining the employment implications for the alternative scenarios.

Moreover, while the focus of the present study is on long-term developments in the industry and prospective skill needs in 2020, it is not possible to neglect potential short and medium-term developments. In other words, what we find when we get to 2020 will depend in part on *how* we get there, since factors which determine the long-term competitiveness of industries, such as investment in R&D, the adoption of new techniques of production, or the ability and willingness to train employees, are inevitably affected by the prevailing economic situation and the common need for companies to remain financial viable

The influence of short-term developments on longer-term ones is particularly relevant in the electro-mechanical industry which is more affected by changes in economic activity over the cycle than many other sectors of the economy since it largely produces capital goods, the demand for which, as demonstrated earlier, fluctuates much more than those for goods in general. The possible scale of the downturn in economic activity in prospect over the next year or two gives added relevance to the consideration of potential developments in the immediate future. Equally, it makes it harder to judge the long-term situation in the industry since the impending recession could conceivably have a devastating effect on output and jobs.

## Trends in value-added, productivity and employment

Despite such uncertainties, some indication of the potential consequences can be gained by examining what happened in past downturns, as well as over the longer-term, in respect of value-added and productivity, which together determine employment.

This is done in Table 15 which shows the growth rates of value-added (in constant prices), productivity (as measured by value-added per person employed) and employment. This covers selected time periods in the two sub-sectors of the industry, as well as in the economy as a whole, and in manufacturing. Data is presented for the EU as a whole, the 'old' and 'new' Member States, and the larger countries for which long-term data are available (there are no comparable data for France before 1999).

**Table 15 Developments in value-added, productivity and employment in electro-mechanical engineering in the EU and selected countries over selected periods**

*Annual average % change*

| | 1995-05 | | | 2001-03 | | | 1991-94 | | |
|---|---|---|---|---|---|---|---|---|---|
| | VA | Prody | Empl | VA | Prody | Empl | VA | Prody | Empl |
| **Total** | | | | | | | | | |
| EU27 | 2.3 | 1.4 | 0.9 | 1.2 | 0.9 | 0.4 | | | |
| EU15 | 2.2 | 1.1 | 1.2 | 1.1 | 0.5 | 0.6 | | | |
| NM12 | 3.7 | 3.8 | -0.1 | 3.6 | 4.1 | -0.5 | | | |
| DE | 1.5 | 1.2 | 0.3 | 0.1 | 0.8 | -0.8 | 1.2 | 2.2 | -1.0 |
| IT | 1.2 | 0.1 | 1.1 | 0.1 | -1.5 | 1.6 | 0.8 | 2.5 | -1.7 |
| UK | 3.0 | 1.9 | 1.0 | 2.4 | 1.6 | 0.8 | 0.2 | 2.2 | -2.0 |
| Other EU15 | 2.8 | 1.2 | 1.5 | 1.7 | 0.9 | 0.9 | | | |
| **Manufacturing** | | | | | | | | | |
| EU27 | 2.1 | 2.9 | -0.8 | 0.1 | 1.9 | -1.8 | | | |
| EU15 | 1.9 | 2.7 | -0.8 | -0.2 | 1.7 | -1.8 | | | |
| NM12 | 6.0 | 6.8 | -0.7 | 5.4 | 7.1 | -1.6 | | | |
| DE | 1.8 | 3.0 | -1.2 | -0.7 | 1.8 | -2.4 | -2.5 | 4.3 | -6.5 |
| IT | -0.5 | -0.3 | -0.2 | -1.8 | -2.6 | 0.8 | 1.3 | 4.3 | -2.8 |
| UK | 0.4 | 3.3 | -2.9 | -1.2 | 3.8 | -4.8 | -1.2 | 5.1 | -6.1 |
| Other EU15 | 2.6 | 3.4 | -0.7 | 0.5 | 2.9 | -2.3 | | | |
| **NACE 29** | | | | | | | | | |
| EU27 | 1.7 | 2.5 | -0.8 | -1.5 | 0.8 | -2.3 | | | |
| EU15 | 1.5 | 1.8 | -0.2 | -1.7 | -0.1 | -1.6 | | | |
| NM12 | 6.1 | 9.0 | -2.6 | 4.3 | 9.7 | -4.9 | | | |
| DE | 0.6 | 1.5 | -0.9 | -2.6 | -0.5 | -2.0 | -6.0 | 3.6 | -9.3 |
| IT | 0.4 | -1.1 | 1.6 | -2.1 | -4.1 | 2.1 | -0.2 | 2.6 | -2.7 |
| UK | -0.3 | 3.1 | -3.3 | -2.0 | 5.3 | -7.0 | -5.0 | 3.5 | -8.2 |
| Other EU15 | 2.9 | 3.3 | -0.4 | -0.9 | 2.0 | -2.8 | | | |
| **NACE 31** | | | | | | | | | |
| EU27 | 5.5 | 5.4 | 0.1 | 0.6 | 3.9 | -3.2 | | | |
| EU15 | 5.3 | 6.1 | -0.8 | 0.5 | 4.6 | -3.9 | | | |
| NM12 | 9.2 | 6.3 | 2.8 | 3.1 | 4.0 | -0.9 | | | |
| DE | 3.8 | 6.8 | -2.8 | 2.5 | 8.8 | -5.8 | -4.4 | 6.6 | -10.4 |
| IT | 1.8 | 1.8 | 0.0 | -0.7 | -2.2 | 1.6 | 1.2 | 5.0 | -3.6 |
| UK | 0.9 | 4.9 | -3.8 | -8.2 | 2.3 | -10.3 | 0.2 | 6.2 | -5.6 |
| Other EU15 | 8.5 | 7.1 | 1.3 | -1.2 | 3.1 | -4.1 | | | |

Note: Other EU15 relates to the EU15 excluding Germany and Italy but including the UK.

As well as showing annual average changes over the period 1995-2005, the table shows changes over the two most recent periods of economic downturn: 1991-1994 (or 1990-1994 in the case of the UK, where the slowdown started earlier) and 2001-2003.

A number of features emerge from the table which are relevant for relating prospective developments in employment in electro-mechanical engineering to future developments in the economy as a whole.

### Long-term trends

Firstly, over the period 1995-2005 (long enough to provide a reasonably representative picture of long-term trends), value-added in manufacturing in the EU, and more especially in the EU15, grew by slightly less than in the rest of the economy. This was particularly the case in Italy and the UK, though not in Germany. In the new Member States, on the other hand, value-added grew more in manufacturing than it did in the rest of the economy.

Secondly, value-added growth in mechanical engineering tended to be less than in manufacturing in the EU15 and, accordingly, even further below the overall rate of growth in the economy. This was particularly so in Italy and the UK, but also in Germany. In other EU15 countries, however, growth of value-added in this sub-sector was slightly higher than in manufacturing, as it was in the new Member States.

Thirdly, growth of value-added in electrical engineering was well above that in manufacturing in both the EU15 and the new Member States, and in most countries, including in Germany, much higher than the growth of the overall economy[11].

Fourthly, productivity growth in both manufacturing and the electro-mechanical industry tended to be higher than in the economy as a whole, which meant that employment tended to decline. This was even the case in the new Member States in both manufacturing and mechanical engineering despite the relatively high growth of value-added. It was also the case in electrical engineering where growth of value-added was especially high, though not in this case in the new Member States, and only in Germany and Italy in EU15.

Fifthly, developments in Italy are especially striking. In effect productivity declined over the 10-year period in both manufacturing as a whole and mechanical engineering, and increased only a small extent in electrical engineering. As a result, employment increased significantly in mechanical engineering and remained unchanged in electrical engineering, despite the poor performance in terms of value-added while in manufacturing as a whole, it declined only slightly in the face of a larger decline in value-added. This has clear implications for possible future developments since it implies an overhang of employment in the industry, especially in mechanical engineering, which could give rise to substantial job losses in the coming years, even without a downturn in economic activity.

**Cyclical downturns**

Next, focusing on the period 2001-2003, which represents the most recent EU downturn (at least in the EU15 economy as a whole if not all EU15 countries), the table shows that value-added in manufacturing was hit harder than the rest of the economy, with a fall in many countries, especially Italy, but also Germany and the UK (despite growth in the UK economy as a whole being higher than in the rest of the EU15).

Secondly, value-added declined by more in mechanical engineering than manufacturing as a whole in these countries, and the decline was common to most parts of the EU15. Accordingly, the industry was hit particularly hard by the downturn in GDP growth, in line with its dependence on the demand for investment goods which tend to be the first area of cutback when sales growth begins to fall off. The value-added of the mechanical engineering industry, therefore, tends to fluctuate considerably more than of the economy as a whole. (This is demonstrated in Figures 23 and 24 which show the growth of value-added in mechanical engineering in relation to the growth of GDP over the period 1971-2006 for Italy and the UK, respectively, two countries for which a long-time series exist on value-added by sector.)

[11] It should be noted that developments in both value-added and employment in the electrical engineering sector involve some estimation since they are based on developments in the broader NACE DL sector (ie NACE 30-33), which includes in particular, TV, radio and electronics equipment as well as instrument engineering.

**Figure 23**

**Growth of value added and value added in machinery and equipment, Italy, 1971-2006**

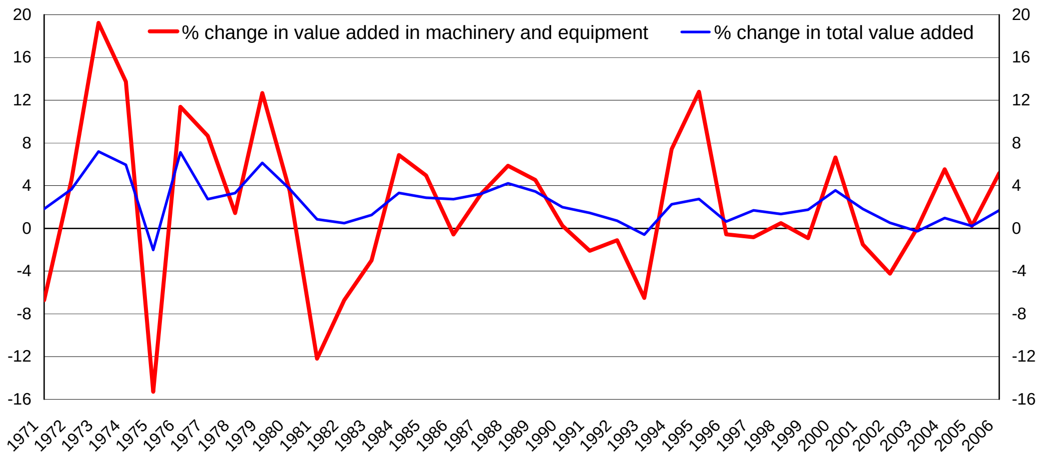
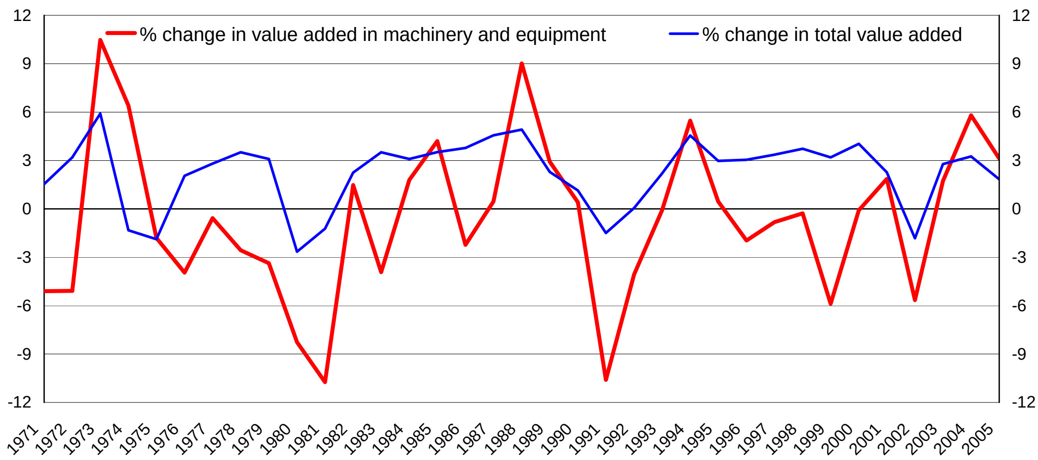



**Figure 24**

**Growth of value added and value added in machinery and equipment, UK, 1971-2005**




Thirdly, there was also a reduction in value-added in the electrical engineering industry in most parts of the EU15, though not in Germany where there was significant growth in the sector, unlike in the rest of the economy. The reduction was especially large in the UK, though this seems to have been part of a longer-term trend decline. Like mechanical engineering, therefore, value-added in the industry tends to be affected more by cyclical fluctuations than the rest of the economy.

Fourthly, productivity growth in manufacturing as a whole was higher in the EU15 than in the rest of the economy, with the result that employment fell significantly. This was not the case in mechanical engineering, however, or at least in many countries, including Germany and Italy, where a decline in productivity softened the effects of the fall in value-added on employment. Indeed, in Italy, the decline was so great that employment actually increased over these two years.

In electrical engineering, on the other hand, there was a significant increase in productivity over this period (Italy apart) which was associated with a significant reduction in employment. This was especially the case in Germany, where value-added increased but employment declined substantially. In Italy, employment increased, again despite the fall in value-added.

The table also shows, for three countries, the experience during the economic downturn 1991-1994 (1990-1993 in the case of the UK). At that time, productivity increased in all three countries at a relatively high rate both in manufacturing and in the electro-mechanical engineering industry, with the result that employment fell markedly..

In Germany job losses amounted to around 10% a year in the electro-mechanical engineering industry as a whole, implying an overall reduction in employment of close to 30% over the three years. In the UK, the overall loss amounted to around 20% over the period, while the reduction in Italy was less, but still amounting to a loss of almost 10% of jobs.

The experience of both periods illustrates what could happen to employment in the industry in the next year or two, especially if the downturn, as widely feared, turns out to be much greater than that in the early 1990s.

## Prospects to 2020

It is difficult to consider long-term developments in the electro-mechanical engineering sector without taking account of the current downturn in economic activity, which will inevitably affect the succeeding years and therefore needs to be explicitly built into the scenarios.

### Developments during the downturn

The experience of the two recent recessions provides some indication of what could happen, although much depends on the eventual scale of the current downturn. The assumption made is that growth in GDP (overall value-added) in the EU15 will be zero during the two years 2009 and 2010, and will then be followed by a recovery, at varying rates. This would make it similar in scale to the slowdown in growth that occurred in several countries over the years 2001-2003, as well as in the early 1990s.

The scale of the downturn could well turn out to be larger than this, but it seems a reasonable basis for formulating scenarios. Each scenario examined here includes this assumption, but vary in terms of the speed of recovery, as well as the consequences for employment. The further (rather positive) assumption is made, again in line with recent experience, that there is some downturn in the rate of economic growth in the new Member States, but that it still averages around 3% a year over these two years. The prospective developments in the two parts of the sector up to 2020, given these assumptions, are examined in turn below.

#### *Projections of developments in mechanical engineering*

On the basis of past experience, no GDP growth for two years in the EU15 is likely to mean a fall in output in manufacturing as a whole, and an even larger fall in mechanical engineering output across Member States. A fall in value-added (measured at constant prices) of 4-5% a year, or around 10% over the two years 2008-2010, would be in line with what happened in the early 1990s.

The impact on employment is less clear, and depends on the response of manufacturers. Do they - as in the downturn of 2001-2003 - try to maintain employment levels, and see productivity decline? Or do they, as in the early 1990s, undertake significant restructuring to maintain productivity growth, resulting in a fall in employment?

Even if employers forego productivity growth in order to try to maintain employment, it is still likely that the number of jobs in the EU15 industry could be cut by up to 10%, on the basis of the value-added assumption. Maintaining productivity growth in order to cut costs and improve efficiency - which might well be forced on the industry by the pressure of global competition - would imply much bigger job losses.

The new Member States, on recent experience, might be less hard hit by the downturn than EU15 countries, though they are unlikely to escape its effects, and economic growth can be expected to slow appreciably. Even if growth remains significantly positive, however, continued productivity gains - reflecting the substantial scope for catching-up, given that value-added per person employed in mechanical engineering in the new Member States is still only around one-fifth of the EU15 average in Euro terms – implies substantial jobs losses.

The possible outcomes for employment on the basis of alternative assumptions about productivity are illustrated in Table 16.

**Table 16 Illustrative projections of developments in the mechanical engineering industry, 2006-10**

| | 2006-08 | | | 2008-10 | | | | | Job losses, 2008-10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VA | Prody | Empl | VA | Prody (1) | Prody (2) | Empl (1) | Empl (2) | (1) | (2) |
| | % pa | | | % pa | | | | | 000s | |
| EU27 | 3.2 | 3.5 | -0.3 | -4.0 | -0.3 | 2.1 | -3.8 | -6.0 | -280 | -440 |
| EU15 | 3.0 | 3.2 | -0.2 | -4.5 | -0.5 | 2.5 | -4.0 | -6.8 | -237 | -396 |
| NM12 | 7.5 | 8.0 | -0.5 | 3.0 | 6.0 | 6.0 | -2.8 | -2.8 | -44 | -44 |
| DE | 3.1 | 3.5 | -0.4 | -4.5 | 0.0 | 2.5 | -4.5 | -6.8 | -93 | -139 |
| IT | 2.7 | 1.7 | 1.0 | -4.5 | -2.0 | 2.5 | -2.6 | -6.8 | -33 | -86 |
| Other EU15 | 3.5 | 4.2 | -0.7 | -4.5 | -0.1 | 2.5 | -4.4 | -6.8 | -111 | -171 |

*Note: 2006-08 esrimated from latest data; 2010 porjected*
*(1) denotes the assumption that employers attempt to maintain jobs*
*(2) denotes that prodtivity growth is mainatined though at a slightly slower rate than before*

These projections are, of course, only illustrative, and intended merely to indicate the scale of what might happen. They have the merit, however, of being based on previous experience, and provide a reasonable benchmark for thinking about alternative scenarios over the longer-term.

They indicate that, given the assumed fall in value-added, close to 300,000 jobs might be lost in the industry in the EU as a whole during 2009 and 2010, even if employers give priority to maintaining employment, and there is no growth in EU15 productivity.

If, on the contrary, productivity growth is maintained, even at a slightly lower rate, job losses in the industry could be close to 450,000 – a reduction of around 13% of so over the two years. Nearly all these job losses are likely to be concentrated in EU15 under both scenarios, though employment in the new Member States can still be expected to fall at a higher rate than before.

Particular uncertainty attaches to prospective developments in Italy where, as indicated above, priority in the past seems to have been given to maintaining jobs, and productivity growth has been much lower than elsewhere in the EU, and sometimes negative. With the expected fall in value-added, however, it will be difficult to avoid some reduction in employment in Italy, especially after several years of low productivity growth. If productivity were to catch up with that in other parts of the EU15, the scale of job losses could be even more substantial than indicated in the table – of the order of 15-20% within a relatively short space of time.

The dilemma facing companies is that, if priority is given to maintaining employment, competitiveness could suffer and it might prove difficult to survive. On the other hand, if priority is given to maintaining productivity growth through improvements in efficiency, this might create industrial unrest and competitiveness might also suffer. Whatever policy is followed in the short-run, it will inevitably affect the long-term as well.

*Projections of developments in electrical engineering*

Electrical engineering is likely to be much less affected by the prospective downturn in economic activity than mechanical engineering if previous experience is a guide, though in relation to the high rates of growth experienced in recent years, the change could still be pronounced. Moreover, productivity growth may slow slightly but, again on past experience, not as much as in the mechanical engineering, and certainly not enough to prevent large scale job losses, as illustrated in Table 17.

**Table 17 Illustrative projections of developments in the electrical engineering industry, 2006-2010**

| | 2006-08 | | | 2008-10 | | | | | Job losses, 2008-10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VA | Prody | Empl | VA | Prody (1) | Prody (2) | Empl (1) | Empl (2) | (1) | (2) |
| | % pa | | | % pa | | | | | 000s | |
| EU27 | 3.7 | 4.2 | -0.4 | -0.7 | 3.3 | 3.9 | -3.9 | -4.4 | -126 | -141 |
| EU15 | 3.5 | 4.5 | -1.0 | -1.0 | 3.5 | 4.0 | -4.3 | -5.0 | -100 | -115 |
| NM12 | 7.0 | 6.0 | 0.9 | 3.0 | 6.0 | 6.0 | -2.8 | -2.8 | -26 | -26 |
| DE | 3.5 | 5.0 | -1.4 | 0.0 | 4.0 | 4.0 | -3.8 | -3.8 | -36 | -36 |
| IT | 2.2 | 2.2 | 0.0 | -2.0 | 0.0 | 4.0 | -2.0 | -5.8 | -9 | -24 |
| Other EU15 | 3.8 | 4.8 | -0.9 | -1.9 | 4.3 | 4.3 | -5.9 | -5.9 | -55 | -55 |

*Note: 2006-08 esrimated from latest data; 2010 porjected*
*Projections (1) and (2) are the same except that in (2) productivity growth iin Italy is assumed to be similar to that in other EU15 countries*

In this case, the main uncertainty again concerns Italy where, in the past, productivity growth had lagged well behind other countries. Indeed, it has tended to match the rate of growth of value-added, such that employment remained constant over the past decade. Whether employment can be maintained in the impending downturn is questionable, however, so that some job loss seems inevitable. Moreover, if productivity growth were to occur at the same rate as in other Member States, job losses could be substantial.

Job losses are also probable in the new Member States, who are unlikely to escape the effects of a slowdown, as occurred in the early part of the present decade. Overall, the loss of jobs in the EU electrical industry could be around 125-140,000 over these two years, a reduction of some 8-9%.

If the potential electrical engineering losses are added to the possible losses in mechanical engineering, this could mean combined job losses of 400-600,000 over the next two years. Longer-term developments and prospects for employment need to be seen against this background.

### Developments beyond the downturn

If the scale of the downturn over the next year or two is uncertain, so is the pace and scale of the recovery. Much depends on what happens during the downturn itself and how far the two parts of the sector emerge with their competitiveness intact or even strengthened, as appears to have happened in the early 1990s when many less efficient producers went out of business.

There are two main projections formulated here, which are the quantitative equivalents of the alternative scenarios. They both start when the downturn is assumed to end: in, or shortly after, 2010.

The first assumes that growth in the EU economy as a whole (including in the various Member States) and in the electro-mechanical engineering sector, is similar to that which occurred over the past 10-15 years.

The second assumes that the industry achieves a higher rate of growth than in the past - partly because of a further strengthening of its international competitiveness (leading to a higher growth of exports on world markets), and partly because of a higher rate of growth of the EU economy. The latter is probably a necessary condition for the industry to expand faster than in the past, given its dependence on investment decisions by other sectors of the economy.

The third projection assumes that productivity growth in mechanical engineering in particular (but also in electrical engineering in Italy) turns out to be higher than in the past in EU15 countries because of global competition, but that this higher productivity does *not* lead to higher sales output.

Such a scenario might reflect a failure by the industry to become more competitive in terms of new products or markets. Equally, however, it could reflect the impact of a relatively slow rate of growth in the European economy on the demand for electro-mechanical engineering products. Although a slowdown in the domestic could, in principle, be offset by increased sales to markets outside the EU, there is a limit to how far this can occur.

The three projections, it should be emphasised again, are merely illustrations of the way things could develop in the industry, and should be regarded as no more than this. They are not forecasts as such, but have been generated in order to ensure that deliberations on the economic prospects for the two sub-sectors, and the implications for skill requirements, do not take place in a ‘quantitative vacuum’.

From experience of past downturns, it can be expected that recovery will be slow to get underway, but for the rate of growth to then increase progressively over a few years. The period 2010 to 2020 could, therefore, be marked by a rate of growth above the long-run trend in both the economy as a whole and in the two parts of the electro-mechanical sector. It is doubtful, however, that growth could be maintained in this way without significant changes, not only in the two sub-sectors, but also in the rest of the economy, so as to provide the increased demand for their products

Table 18 is based on average growth rates of value-added over the period 2010-2020 in the two sub-sectors, which is reasonably in line with the long-term growth rates experienced over similar periods in the past (see the first set of columns). On this basis, very little employment growth can be expected in either sub-sector, given the offsetting growth in productivity. The main areas of growth in the EU would be in electrical engineering in the new Member States, who have benefited from some relocation of production over the past decade, and in mechanical engineering in Italy, though this would depend on Italian productivity growth remaining low, which may well be unsustainable in the longer-run.

**Table 18 Projections of longer-term developments in the electro-mechanical engineering sector, 2006-2020**

| | 2010-2020 (1) | | | 2010-2020 (2) | | | 2010-2020 (3) | | |
|---|---|---|---|---|---|---|---|---|---|
| **NACE 29** | VA | Prody | Empl | VA | Prody | Empl | VA | Prody | Empl |
| EU15 | 2.5 | 2.2 | 0.2 | 4.2 | 3.2 | 1.0 | 2.5 | 3.0 | -0.5 |
| NM12 | 5.5 | 5.5 | 0.0 | 6.5 | 5.5 | 0.9 | 5.5 | 5.5 | 0.0 |
| DE | 2.0 | 2.2 | -0.3 | 4.2 | 3.2 | 1.0 | 2.2 | 3.0 | -0.7 |
| IT | 2.2 | 1.5 | 0.7 | 4.0 | 3.2 | 0.7 | 2.2 | 3.0 | -0.7 |
| **NACE 31** | | | | | | | | | |
| EU15 | 5.5 | 5.5 | 0.0 | 6.5 | 5.5 | 0.9 | 5.5 | 6.0 | -0.5 |
| NM12 | 7.2 | 6.0 | 1.2 | 7.7 | 6.0 | 1.7 | 6.7 | 6.0 | 0.7 |
| DE | 4.5 | 6.0 | -1.4 | 6.0 | 6.0 | 0.0 | 4.7 | 6.0 | -1.2 |
| IT | 2.5 | 2.5 | 0.0 | 3.5 | 3.0 | 0.5 | 2.5 | 6.0 | -3.3 |

*Note: Projection (1) is broadly in line with past trends in the two sectors*
*(2) assumes high growth growth of value-added*
*(3) assumes the same growth as in (1) but higher productivity growth*

It is possible to envisage employment growth in both sub-sectors across the EU as a whole (but not necessarily in all countries) over the period 2010-2020 if significantly higher value-added growth could be generated, though the positive effect on jobs would be likely to be offset in part by the increased productivity needed to achieve the increased competiveness required to boost sales, which would itself be the result of higher growth. There are various mechanisms by which this could occur, as discussed later, generally involving increased investment embodying the latest technical know-how

It also possible, however, that, under a modest growth scenario (i.e. growth is no higher than in the past) increases in productivity in the two sub-sectors (as a result of new, more automated and less labour-intensive methods of production) could more than cancel out the effects of the increase in value-added. Job losses would then continue, even if at a considerably lower rate, even after the downturn comes to an end. The potential losses are especially large in Italy, particularly in the electrical engineering sub-sector where firms tend to be less competitive than in mechanical engineering, where past productivity growth has been much less than in the rest of the EU.

## Likelihood of alternative scenarios

The scenarios outlined above are based on past experience and, as such, should already embody the effects of all past drivers of change as reflected in the historic trends and structures of output, productivity and employment. They take explicit account, however, of the fact that the EU economy is already in a major downturn, and that there is need to consider its possible effects (based on the experiences of the two last downturns in the EU economy) when building scenarios for the period to 2020.

As regard the period to 2010 – during which GDP growth is assumed to be zero – there are two alternative assumptions.

The first is that, despite the fall in output that is implied, employers attempt to maintain levels of employment, for whatever reasons – a desire to retain workforce loyalty in anticipation of future recover, political pressures on industry to avoid the high social costs of unemployment, or simply a reduction in efficiency because the industry fails to invest in new technologies, equipment or training in the face of falling demand and lack of revenue.

The second is that productivity growth rates are slightly lower than in the past – possibly reflecting some reduction in efficiency because of lower levels of output or lack of continued investment, but that this effect is relatively limited so that the effects of the reduction in output is mainly seen in terms of a drop in employment.

As regards the period from 2010 to 2020, three alternative assumptions are presented.

The first is that both output growth and productivity growth continue at much the same rate as in the past – implying that, while the new technological and organisational developments discussed in the chapter on drivers of change continue to be incorporated into typical working practices, there is no change of pace or acceleration in this respect

The second is that there is an increase in the rate of absorption of technological and organisational developments in these industries, and that this serves to raise the competitive performance of these industries (reflected in productivity, but also in product ‘quality’ as judged by ‘users’) such that they increase output sales on world markets.

The third is similar to the second in that technological and organisation advances are taken on board so that productivity increases, but that the outcome is less satisfactory for the industry in that it does not result in increased sales and output for whatever reason – this could be because other countries (such as China) improve their competitive performance at an even faster rate and take an increased share of the world market, or it could simply be due to low rates of global or European demand, where the EU might maintain its share, but nevertheless suffer a fall in output, or a fall in the rate of growth of its output.

The likelihood with respect to the short-run recession period will probably be as much affected by social and political concerns as economic ones. Moreover, past experience in EU15 suggests that different countries may well go down different paths, with varying consequences: Italy having been prepared to maintain employment at the cost of zero or negative productivity growth, the UK being prepared to see much of its industry disappear because it was judged not to be of strategic importance in the context of a successful financial sector.

Over the long-run, up to 2020, the implications of alternative outcomes are such that it is particularly important to consider the likely impact of the combined effects of the complex combination of technological and organisation changes that were discussed in Chapter 2 above, and which would seem to be fundamental in determining the future competitiveness of the industries. To what extent are these alternative economic scenarios compatible with our expectations regarding technological and organisational developments, and what is the likelihood and consequences of one or the other turning out to be more or less probable?

### Determinants of competitive performance

Of course, the factors that determine competitiveness are interrelated, and causality can run in many directions. The pace at which technological advances are adopted and applied by firms may, therefore, fall if advances are primarily driven by the pace of market demand, or if companies rely, directly or indirectly, on short-term government financial support for research and development. On the other hand, when overall demand falls, those firms that make the best use of all available technological and organisational possibilities to improve their performance can gain market share at the expense of competitors, and even maintain overall output in a shrinking market.

It is obviously difficult to judge in which directions these sectors will move overall, not least because of the evidence of divergent trends between EU15 countries in the past, as well as the differences in circumstances between EU15 and EU12 countries at present. It is even more difficult to judge to what extent these changes can be significantly influenced by policy initiatives of various kinds.

Hence, while Europe holds a strong position in respect of innovation and quality, from which it will be difficult for competitors to dislodge it over the short to medium term, this will not necessarily hold true as far ahead as 2020. In the end, much depends on the capacity/willingness of all the actors in the business chains in each of these countries to implement a successful common strategy, defending their advantages, investing in innovation and competences, increasing the strength of their production chain, increasing the involvement of employees, and investing in new companies and new activities, including support for academic spin offs.

Hence, while it is true that the peak of excellence achieved by European producers cannot be matched easily or quickly, it is also true that their competitive advantage could easily decline in a global economy, in the absence of such commitments. This is particularly true vis-a-vis Far Eastern countries which have largely targeted export consumer goods markets to date, but who could shift their focus much more on their domestic needs for capital goods if global market conditions changed significantly.

There are, therefore, reasons to be concerned. New industries are evolving quickly. The demand from the automotive industry in Europe over the longer-term for new plant and equipment is uncertain. For the moment China is not a producer of one of the main products of mechatronics - the robot - but it could probably become one if it chooses.

Moreover, labour cost issues are a continuing concern for European producers, not just with regard to low or semi-skilled labour, but also in relation to jobs with high technical or scientific content and competences, which is already a factor in the migration of some research laboratories and R&D centres from EU15 countries to the new Member States.

## The balance of factors

While competitive forces are strong, the underlying strengths of European industry should not be overlooked.

### Positive factors

First, regulatory and safety standards concerning product specification and use, the scale of investment needed in many of the sub-sectors, the importance of embodied knowledge and know-how as well as patents, together with the all-important question of a company's reputation, all provide a real and effective obstacle to new entrants, especially at higher ends of the sector's market.

Secondly, the diverse patterns of ownership in many electro-mechanical sub-sectors, where SMEs play an important role, together with non-publicly quoted companies in general, may also help explain the ability of many such firms to maintain a long-term perspective and avoid the short-term focus on share prices and the destructive restructuring which this can bring about.

Thirdly, the strong policy focus on the sector at EU level - with routine monitoring of competitive performance in key sub-sectors by the European Commission, and with periodic, high profile, expert reports which are communicated to EU and national authorities - serves to maintain awareness of the sector's contribution to the economy and the need to address challenges.

Fourthly, while the comparative advantage of newly industrialized countries in these sectors will grow, this appears so far to have been at the expense more of the US and Japan than of Europe. Moreover, in the end, competitive advantage is only ever comparative and not absolute so that, even if the European industry is forced to rationalise and restructure - and even to relocate the more labour-intensive processes to lower cost countries – there is little reason why, with its initial advantages, it cannot maintain its leadership in many of the most important, dynamic and growing sub-sectors, as well as in the 'high end' of the sectors generally

Fifthly, energy shortages and climate change concerns could encourage a massive re-capitalisation and restructuring of all investment goods industries – notably in manufacturing, but also construction – in order to incorporate new technologies, meet new regulatory standards, and take account of changing relative prices of materials and labour of different qualities. This, however, could work to the advantage of established producers in European countries most active in raising standards in this way.

**Matters of concern**

Positive factors need to be set against concern about the capacity and commitment of the companies in the two parts of the sector to maintain their leading edge position in the future, not least in relation to R&D and technology, in the face of global competitors, as well as the willingness, or otherwise, of national governments to adopt a more European perspective when considering how best the industry can contribute to the Union's goals.

Over the medium and longer-term, and up to 2020 in particular, there are few reasons to doubt the potential of companies in the electro-mechanical sector taken as a whole to continue to perform in much the same way as over the past 10-15 years. Indeed, there is even the possibility that the sector's performance could be further enhanced if general economic developments and policy decisions concerning public investment come together in a positive, and mutually re-enforcing, way. The key question, however, is whether the companies concerned can realise this potential as well as whether the context in which they are operating turns out to be more or less favourable.

There are a number of prospective developments which will affect the outturn. First, those countries that are industrializing and which had, until relatively recently, been heavily dependent on developed economies for meeting much of their capital goods needs, are now themselves becoming important producers, with China now accounting for some 10% of machinery and equipment exports, and for some 16.5 % of electrical equipment exports. Rates of investment in R&D in China and other Asian economies appear to be growing considerably faster than GDP (some 17% a year in China and even higher in Korea and Taiwan), while the number of engineers and scientists graduating each year already far exceeds the output of European universities.

Secondly, the cost advantages of enlargement, which has helped maintain the competitiveness of parts of the electrical equipment sector through the transfer of activities to the new Member States, is being progressively eroded as living standards, and wage levels, rise with the gradual convergence towards EU15 levels. This is already noticeable in basic industries such as textiles and clothing, where production that had been relocated from EU15 countries is now being relocated once again to neighboring countries to the east and south, as well as to Asia[12]. There are also, however, an increasing number of cases in the electrical equipment industry[13].

Thirdly, the maturity of European industry, which is perceived as an advantage in the short-run, could prove an issue in the longer run if basic technologies change in fundamental ways, as has happened to some extent with the development of computer-controlled machine tools. This could, however, go much further, especially in the electrical equipment sector, if sources and methods of energy supply continue to diversify in ways that allow dynamic businesses from other sectors, and from countries outside Europe, to compete effectively.

Fourthly, the current patterns of fragmented ownership – with reliance on internal and bank financing for development in many cases, which has often been regarded as a source of strength and continuity to date – could prove a drawback if future large-scale competitors, with access to appropriate levels of funds and managerial skills, were able to customise more standardised basic products. This might give them economies of scale advantages combined with the advantages of custom-built products, especially in the machinery and equipment sector.

Fifthly, and related to this, the present financial crisis has highlighted the instability of financial companies, and private equity funds in particular, which have in the recent past acquired many companies in the engineering sector and which could be forced to cut off sources of funding or attempt to sell off their holdings, so giving rise to even more uncertainty about the ability of the industry to maintain competitiveness.

In sum, therefore, future prospects depend very much on the ability of the sector to respond to the triple challenge of:

- the downturn in world trade and in the global economy, which will have a particularly negative impact on capital goods industries, and which has been investigated in detail above;
- the continued development of competitors in the developing economies, notably China, which could erode the current strong position of the industries;
- the potential technological transformation of important parts of the electrical machinery sector in particular in response to changing energy needs and uses, which could bring into play new competitors as well as leading to a decline in traditional markets.

[12] See European Monitoring Centre on Change reports and the cases of delocalisation reported in the European Restructuring Monitor maintained by the European Foundation for Improvement in Living and Working Condition in Dublin. Among the many examples is the German textile company, Mustang Marcali, which shifted production from Hungary to Asia at the beginning of 2007.

[13] An example is the Japanese Sanyo company which relocated production of rechargeable batteries from Hungary to China at the beginning of 2008 citing increased labour costs as the main reason.

In these and other respects, there are particular uncertainties about the capacity of the sector to respond to these challenges, arising not only from financial and ownership issues but also from possible shortages of particular skills on the labour market and the response of companies in the sector in different parts of the EU to these.

The persistent and widespread concerns about skill shortages are well documented, but it is notable that general industry strategy reports make few references to human resource issues. Where they do, they focus almost entirely on university level education and the need to encourage more science and technology graduates. This is clearly important, but it is equally important to address potential skill shortages and changing competence needs at middle and lower levels, and the role and responsibilities of the industries concerned themselves in tackling these, which features hardly at all in such reports.

The scale and nature of the challenges likely to be faced in these respects is the subject of the next chapter.

# Part 5 – Implications for employment, skills and competences

The scenarios set out above, combining two alternative possibilities for the period of downturn up to 2010, and the three scenario options for the period to 2020, have significantly different implications in terms of both the overall number employed in the sector and their division between different jobs and the skills and competences. These are considered below, taking account of the potential impact of the non-economic – i.e. technological and organisational – changes that are likely to affect the development of the industries in the sector over this period.

The implications of the various scenarios for employment over the period up to 2020, starting from 2006, the latest year for which historical data are available, are shown in Table 19. Again it should be stressed that the figures are intended to be illustrative only of the possible scale of future changes and of differences between scenarios.

**Table 19 Projected changes in employment in the electro-mechanical engineering sector, 2006-20**

| | Projection (1) | | | Projection (2) | | Projection (3) | | |
|---|---|---|---|---|---|---|---|---|
| | 2006-10 | 2010-20 | 2006-20 | 2010-20 | 2006-20 | 2006-10 | 2010-20 | 2006-20 |
| **NACE 29** | *% change over the period* | | | | | | | |
| EU27 | -7.9 | 1.9 | -6.2 | 10.1 | 1.3 | -12.1 | -3.7 | -15.4 |
| EU15 | -8.3 | 2.4 | -6.1 | 10.1 | 0.9 | -13.6 | -4.8 | -17.8 |
| NM12 | -6.5 | 0.0 | -6.5 | 9.9 | 2.8 | -6.5 | 0.0 | -6.5 |
| DE | -9.5 | -0.1 | -9.6 | 10.1 | -0.4 | -13.9 | -7.1 | -20.0 |
| IT | -3.2 | 7.6 | 4.2 | 7.5 | 4.1 | -11.5 | -7.1 | -17.8 |
| **NACE 31** | | | | | | | | |
| EU27 | -8.5 | 2.1 | -6.5 | 12.2 | 2.7 | -9.7 | -1.4 | -11.0 |
| EU15 | -10.3 | 0.0 | -10.3 | 9.9 | -1.4 | -12.0 | -5.1 | -16.5 |
| NM12 | -3.8 | 7.3 | 3.2 | 17.8 | 13.3 | -3.8 | 7.3 | 3.2 |
| DE | -10.2 | -11.2 | -20.2 | 0.0 | -10.2 | -10.2 | -11.2 | -20.2 |
| IT | -4.0 | 0.0 | -4.0 | 4.9 | 0.8 | -13.8 | -28.5 | -38.4 |
| **NACE 29** | *Change in number employed (000s)* | | | | | | | |
| EU27 | -302 | 67 | -235 | 352 | 50 | -462 | -125 | -587 |
| EU15 | -251 | 67 | -184 | 279 | 28 | -411 | -125 | -536 |
| NM12 | -51 | 0 | -51 | 73 | 22 | -51 | 0 | -51 |
| DE | -101 | -1 | -102 | 97 | -4 | -147 | -65 | -212 |
| IT | -20 | 47 | 27 | 47 | 26 | -74 | -40 | -114 |
| **NACE 31** | | | | | | | | |
| EU27 | -141 | 33 | -108 | 186 | 45 | -162 | -21 | -183 |
| EU15 | -123 | 0 | -123 | 106 | -17 | -144 | -53 | -198 |
| NM12 | -18 | 33 | 15 | 80 | 62 | -18 | 33 | 15 |
| DE | -50 | -49 | -99 | 0 | -50 | -50 | -49 | -99 |
| IT | -9 | 0 | -9 | 10 | 2 | -30 | -53 | -83 |

These projections, as noted above, are based on different assumptions about the relationship between output and employment:

- Scenario 1 assumes that trends in output (value-added) and productivity – which determines the outcome in terms of employment - remain much as in the past
- Scenario 2 assumes a higher rate of growth of output (value-added) compared with the past, as well as improved productivity growth, which results in a positive effect on employment

- Scenario 3 assumes a continuing improvement in productivity, but without the higher rate of growth of output (value-added), which has a negative effect on employment.

Overall the table indicates that, even under the optimistic scenario of higher growth (scenario 2), the industry is unlikely to be employing substantially more people in 2020 than at present. In other words, the positive growth in employment that could be expected from the most optimistic scenario for 2010 to 2020 – close to 550,000 - would not be much greater than the job losses experienced in the impending downturn, if this occurs on the scale projected.

If the post-downturn future follows a similar path to the past – scenario 1 - then the numbers employed in the industry in 2020 could be significantly less in the EU as a whole (around 350 thousand less) than they were before the downturn. If the growth of productivity is maintained during the downturn, but moves to a higher rate in subsequent years, but without having any significant positive effect on output growth – scenario 3 - then the overall loss of jobs would be substantial by 2020 (the table shows the sector employing some 17-18% less in the EU15 than in 2006, equivalent to a reduction of around 730,000).

The implications for these scenarios for the demand for particular skills, or types of labour, is examined in the next section. This combines the projections of overall employment with projections of the changing skill structure of the work force in the two parts of the industry, based on developments in the composition of jobs over the recent past and what we know about the kinds of skill for which demand is growing, and those for which it is declining.

## Projections of skill needs

The occupational structure of employment in the two parts of the electro-mechanical sector has tended to shift towards higher qualified jobs in recent years, and away from skilled manual jobs and those on the production line. These shifts are likely to continue in future years, almost irrespective of the rate of growth of total employment in the sector, as technology advances and computer-operated processes become increasingly important in production, and as more weight is attached to professional functions such as customer relations and finance as well as engineering skills. The implications of recent trends continuing up to 2020 in the mechanical engineering industry are shown in Table 20 and in the electrical engineering industry in Table 21.

**Table 20 Projections of the changing structure of employment in the mechanical engineering industry, 2007-2020**

| | EU15 | | Change | New Member States | | Change |
|---|---|---|---|---|---|---|
| | 2007 | 2020 | 2007-20 | 2007 | 2020 | 2007-20 |
| | % Total employed | | % point | % Total employed | | % point |
| **Managers** | **7.5** | **7.4** | **-0.1** | **4.8** | **5.2** | **0.4** |
| **Professionals+technicians** | **27.3** | **32.4** | **5.1** | **20.1** | **19.7** | **-0.4** |
| Engineers | 16.8 | 19.0 | 2.2 | 11.6 | 11.4 | -0.2 |
| Computer specialists | 1.5 | 1.8 | 0.3 | 1.5 | 2.0 | 0.5 |
| Other professionals | 9.0 | 11.7 | 2.6 | 7.0 | 6.3 | -0.7 |
| Business, finance, sales | 4.4 | 5.6 | 1.2 | 2.3 | 2.8 | 0.4 |
| Aministrative+other | 4.6 | 6.1 | 1.5 | 4.7 | 3.5 | -1.1 |
| **Office workers** | **9.4** | **7.7** | **-1.7** | **5.6** | **4.7** | **-0.9** |
| **Skilled manual workers** | **34.7** | **30.9** | **-3.8** | **45.6** | **43.9** | **-1.7** |
| Metal moulders | 5.9 | 4.9 | -1.0 | 10.4 | 13.9 | 3.6 |
| Tool makers | 6.8 | 5.7 | -1.2 | 19.3 | 12.4 | -6.9 |
| Mechanics | 12.5 | 9.7 | -2.8 | 7.9 | 9.5 | 1.6 |
| Electricians+others | 9.4 | 10.5 | 1.1 | 8.0 | 8.0 | 0.0 |
| **Semi-skilled workers** | **15.2** | **14.8** | **-0.5** | **20.4** | **24.6** | **4.3** |
| Machine operators | 13.9 | 13.4 | -0.5 | 18.5 | 23.4 | 4.9 |
| Drivers | 1.3 | 1.4 | 0.1 | 1.8 | 1.2 | -0.6 |
| **Other** | **5.8** | **6.8** | **1.1** | **3.5** | **1.8** | **-1.7** |

**Table 21 Projections of the changing structure of employment in the electrical engineering industry, 2007-2020**

| | EU15 | | Change | New Member States | | Change |
|---|---|---|---|---|---|---|
| | 2007 | 2020 | 2007-20 | 2007 | 2020 | 2007-20 |
| | % Total employed | | % point | % Total employed | | % point |
| **Managers** | **7.4** | **8.6** | **1.2** | **3.3** | **2.6** | **-0.7** |
| **Professionals+technicians** | **27.6** | **29.1** | **1.4** | **17.8** | **18.9** | **1.1** |
| Engineers | 16.5 | 16.4 | -0.1 | 9.6 | 10.8 | 1.2 |
| Computer specialists | 2.1 | 2.4 | 0.3 | 1.4 | 1.7 | 0.3 |
| Other professionals | 9.0 | 10.2 | 1.2 | 6.8 | 6.4 | -0.3 |
| Business, finance, sales | 4.8 | 6.0 | 1.2 | 1.7 | 1.6 | -0.1 |
| Aministrative+other | 4.2 | 4.2 | 0.1 | 5.0 | 4.9 | -0.1 |
| **Office workers** | **9.6** | **8.0** | **-1.5** | **4.8** | **4.5** | **-0.3** |
| **Skilled manual workers** | **26.1** | **28.0** | **1.9** | **24.9** | **17.5** | **-7.5** |
| Metal moulders | 2.1 | 2.2 | 0.1 | 3.7 | 4.9 | 1.1 |
| Tool makers | 2.2 | 2.2 | 0.0 | 4.0 | 0.6 | -3.4 |
| Mechanics | 3.5 | 4.0 | 0.5 | 1.6 | 1.3 | -0.3 |
| Electricians+others | 18.3 | 19.6 | 1.3 | 15.6 | 10.7 | -4.9 |
| **Semi-skilled workers** | **22.9** | **19.9** | **-2.9** | **41.9** | **52.0** | **10.1** |
| Machine operators | 22.0 | 18.9 | -3.0 | 40.1 | 50.6 | 10.5 |
| Drivers | 0.9 | 1.0 | 0.1 | 1.9 | 1.5 | -0.4 |
| **Other** | **6.5** | **6.4** | **-0.1** | **7.2** | **4.5** | **-2.8** |

In the case of mechanical engineering, the table indicates that, while the relative importance of most jobs for professionals and technicians can be expected to increase over the next 10-12 years, at least in EU15 countries, the relative importance of most jobs for manual workers are set to diminish, again in EU15. The main exceptions are jobs for electricians among skilled workers, reflecting the trend towards computerisation and digital control methods. It is still the case, however, on the basis of current trends, that there will be more manual workers employed in the industry (skilled, semi-skilled and low skilled – the ‘other’ category in the table) than non-manual workers.

In the new Member States, on the other hand, some types of job for skilled manual workers, given recent trends, seem set to increase, such as for metal moulders and mechanics and, more generally, for machine operators on production lines. Indeed, the latter could increase further if the scope for relocating production in the various parts of this industry from EU15 countries, which so far except in specific areas (such as domestic electrical appliances) has been limited, widens.

The likely pattern of change in the skill structure of employment in electrical engineering is very similar, though the relative importance of most types of job for skilled manual workers in EU15 countries seems set to remain much the same, or to increase. This is particularly so in respect of electricians for the same reasons as for mechanical engineering. The shift away from semi-skilled workers on production lines is likely to be much more pronounced than in the other sub-sector, reflecting the greater scope for relocating parts of the industry to the new Member States, or further afield.

Developments in electrical engineering in the new Member States are, in large measure, likely to be the mirror image of trends in EU15, but with a significant drop in demand for skilled manual workers, and a very marked shift towards jobs for machine operators on production lines.

## Demand for different skills

An analysis of shifts in the composition of skill needs does not, of itself, indicate whether there is likely to be an absolute expansion or contraction of particular jobs - in a contracting industry, an increase in the importance of a particular type of job might still mean that fewer people with those skills are required in future years. Projected trends in the skill structure of jobs need, therefore, to be combined with projections of the overall level of employment to give an indication of the extent to which the demand for specific skills is likely to expand or contract.

Table 22 shows the prospective changes in the demand for particular types of worker in mechanical engineering in 2020 compared with 2007. It shows that the demand for skilled manual workers in EU15 (with the exception of electricians) and for office workers, can be expected to decline significantly over this period, even if there is a relatively high growth of value-added – scenario 2. It also shows that, with a slightly higher rate of productivity growth than in the past, but no increase in sales – scenario 3 - there would be a reduced demand (in absolute numbers) for all types of skill.

Nevertheless, the demand for highly qualified people to work in various business and administrative functions, as well as for engineers and computer scientists, is likely to be significantly higher in 2020 than at present, even if past trends merely continue and do not accelerate – scenario 1. This is likely to be even more the case if sales were to grow at a faster rate than in the past – scenario 2 – which raises the question of whether the industry is likely to be able to recruit the people with the qualifications needed in the face of demand for such people from other parts of the economy, which might well appear to them to be more attractive. Indeed the recruitment of such people is likely to be critical for the industry to be able to achieve a higher rate of sales in the first place.

**Table 22 Projections of the change in employment in the mechanical engineering industry, 2007-2020**

*% Change in employment*

| | EU15 | | | New Member States | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) |
| Managers | -8 | -1 | -19 | 1 | 11 |
| Professionals+technicians | 11 | 20 | -8 | -8 | 1 |
| Engineers | 6 | 14 | -11 | -8 | 1 |
| Computer specialists | 11 | 20 | -8 | 25 | 38 |
| Other professionals | 21 | 30 | -2 | -16 | -7 |
| Business, finance, sales | 18 | 27 | -3 | 10 | 21 |
| Aministrative+other | 24 | 33 | 0 | -29 | -22 |
| Office workers | -23 | -18 | -28 | -21 | -13 |
| Skilled manual workers | -17 | -10 | -24 | -10 | -1 |
| Metal moulders | -22 | -16 | -27 | 26 | 38 |
| Tool makers | -22 | -16 | -27 | -40 | -34 |
| Mechanics | -27 | -22 | -30 | 12 | 24 |
| Electricians+others | 5 | 13 | -11 | -6 | 3 |
| Semi-skilled workers | -9 | -2 | -19 | 13 | 24 |
| Machine operators | -10 | -3 | -20 | 18 | 30 |
| Drivers | -2 | 6 | -15 | -39 | -32 |
| Other | 11 | 19 | -8 | -51 | -46 |
| Total | -6 | 1 | -18 | -6 | 3 |

*Note: (1) Projection assuming past trends continue*
*(2) Projection assuming high growth*
*(£) Projection assuming higher productivity growth*

The same kind of picture is evident for the electrical engineering industry where, under the increased productivity scenario – scenario 3 - all types of job in the EU15 could show a fall between now and 2020 (Table 23).

**Table 23 Projections of the change in employment in the electrical engineering industry, 2007-2020**

*% Change in employment*

| | EU15 | | | New Member States | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) |
| Managers | 5 | 16 | -7 | -19 | -11 |
| Professionals+technicians | -5 | 4 | -13 | 9 | 19 |
| Engineers | -10 | -1 | -16 | 15 | 26 |
| Computer specialists | 4 | 15 | -7 | 22 | 34 |
| Other professionals | 2 | 12 | -9 | -3 | 7 |
| Business, finance, sales | 12 | 23 | -3 | -6 | 3 |
| Aministrative+other | -9 | 0 | -15 | -1 | 9 |
| Office workers | -24 | -17 | -25 | -4 | 5 |
| Skilled manual workers | -3 | 6 | -12 | -28 | -21 |
| Metal moulders | -7 | 2 | -15 | 34 | 47 |
| Tool makers | -8 | 1 | -15 | -84 | -82 |
| Mechanics | 2 | 12 | -9 | -15 | -7 |
| Electricians+others | -3 | 6 | -12 | -30 | -23 |
| Semi-skilled workers | -21 | -14 | -23 | 27 | 39 |
| Machine operators | -22 | -15 | -24 | 29 | 42 |
| Drivers | 2 | 12 | -9 | -20 | -12 |
| Other | -11 | -2 | -17 | -37 | -31 |
| Total | 0 | -1 | -16 | 0 | 12 |

*Note: (1) Projection assuming past trends continue*
*(2) Projection assuming high growth*
*(£) Projection assuming higher productivity growth*

Although the foreseeable increase in demand for highly qualified personnel might not be as high in electrical engineering as in mechanical engineering, it could still be significant and run into the same kind of recruitment problems. This, of course, is even more the case if a higher rate of sale growth were to be achieved.

Despite the projected decline in the demand for skilled manual workers in the mechanical engineering industry and, indeed, in the sector overall, despite the possible increase in the electrical engineering part of it, it is still the case that under the high growth scenario in particular, companies could still likely to be faced with the need to replace workers due to retire between now and 2020. The loss of such workers in a number of countries could well outpace the reduction in demand for them and this, of course, will be even more the case if output were to grow at a higher rate than in the past. Accordingly, the problem of recruiting suitable replacements could become acute given the probable decline in young people coming on to the labour market with the requisite skills and qualifications.

The problem could be especially acute in the electrical equipment part of the industry where, under a high growth scenario, the need for skilled manual workers could be higher in 2020 than now. In both parts of the sector, moreover, the demand for electricians and electronic specialists is set to increase, perhaps significantly, up to 2020 and retirements will only exacerbate the potential recruitment problem.

This applies equally to the demand for engineers, which would also increase in absolute terms in the mechanical engineering parts of the sector even without any significant growth in output over and above past trends and where, as indicated above, the rate of retirement is also likely to be relatively high.

The question also arises as to the possibility of the occupational structure of employment changing in a different way in the future than in the past, of past trends not simply continuing at their recent pace but perhaps accelerating. This, indeed, could well happen, under the scenarios of an increased rate of technological advance, where the need for engineers, computer programmers and electronic specialists would increase with the higher rate of advance. The effect would be an even higher rate of growth of demand for the skills concerned, coupled perhaps with a larger reduction in jobs for other skilled manual workers and semi-skilled workers.

The nature of the recruitment problems facing the industry would, however, not be substantially different. It would just be that the scale of the problems and the importance of overcoming them would be that much greater. If they fail to do so, then the result would be that the pace of technological change would slow and EU industries would lose competitiveness and market share. The fact that demand for labour would decline would help resolve the recruitment problems but at the expense of a contraction of an industry which remains a major source of export earnings – and therefore income – for the EU economy.

# Part 6 – Strategic choices to meet competence and skills needs

Companies in the mechanical and electrical engineering industries do not have a great deal of choice regarding their needs in terms of competence and skills. In the global and European markets in which they operate – the higher end of the capital goods for investment - production systems are largely determined by the prevailing leading-edge technologies and associated optimal methods of efficient work organisations, and it is not realistic to opt for alternative arrangements, except for relatively small specialist niche markets.

In other words, across much of the sector, differences in performance between firms, regions, and countries will largely be determined by the quality of the products produced and the market they specialise in, and whether these markets are mature, growing or in decline. The implications can be seen most clearly in relation to production line activities being progressively transferred from EU15 countries to the new Member States or further afield, where the only real change is often in the level of wages being paid to workers. It is equally true, however, at the other end of the scale, in, for example, the design and production of robots, where the best will tend to drive out the rest.

Where the industries have some of their most strategic choices to make are in respect of their commitment to R&D, the application of technologies (hybrid or otherwise) and modern work organization methods, in order to maintain their competitive positions in different markets.

A more general challenge facing the industry is in respect of energy. This takes two forms. First, the industries, as major energy users, tend to be at the forefront of efforts to reduce energy costs and respect environmental concerns, as discussed in the drivers of change chapter. Exogenous factors can come into play, in so far as some countries have access to cheaper sources of energy than others but, in general, it would be reasonable to assume, as a starting point, that all firms, wherever they are located in the world, face similar challenges with similar options available to them – although the costs of both action and inaction could be high, if the wrong choices are made.

Secondly, a significant part of the sector is a major supplier to the energy industry. The opening up of Europe's electricity generation markets could have significant effects on different nationally-based industries, some of which have benefited from relatively protected markets and now face increased competition from both within Europe and outside. Again, the choices and consequences are important but, with respect to employment and skills, the main effect is likely to be in terms of the volume of jobs rather than their structure since, here again, labour requirements are largely technologically determined.

In terms of the workforce, the main choices facing companies in the past appear to have been about whether or not to retain workers in periods of economic difficulty (where Germany and Italy offer contrasting examples) and the extent to which the industries concerned chose to rely on social partner-backed apprenticeship systems to ensure an adequate supply of manual skills (where Germany and the UK offer contrasting examples).

In both these respect, however, the future is likely to be different from the past. Italian practices – which have wiped out productivity growth in a number of years in order to maintain employment – appear unsustainable, while the failure of the UK to maintain an adequate level of investment in skills is reflected in the sharp decline in output and employment in its engineering industries.

There is a widespread recognition across the EU that competence requirements are rising in the industry, as they are in the economy as a whole, which will mean higher rates of recruitment of graduates, especially science and engineering graduates. However, there is relatively little sign of substantive efforts being made to ensure that this happens. Equally, there is only limited evidence of action being taken to address skill needs further down the scale among manual workers, who, as indicated above, are still likely to make up the larger part of the workforce over the next 10-15 years.

The evidence suggests that changes in the overall structure of employment are largely technologically determined, and there is really only one viable paradigm in the long-run. If the industries do not adopt the prevailing leading-edge standards, they will almost certainly lose market share and employment, probably at a rapid rate.

On the contrary, if the industries invest in competences and build on their strengths, in line with the technological and organizational possibilities that are evolving, then they could achieve the more positive outcomes, at least in terms of output, that are foreseen in the scenarios.

One of the major issue concerning skills is the extent to which the industries rely on national education and training institutions to meet their needs as opposed to delivering education and training themselves, and the degree of co-operation that exists between the industry and the education and training institutions as well as between the social partners.

In these respects, there are major differences between countries, with little progress sought or achieved in terms of convergence of approach or standards. In these circumstances, what conclusions can be drawn regarding the ways forward in terms of competence building to tackle the future?

If, as argued above, there is a clearly defined path along which the industries need to develop and which embodies increasing high standards of performance, including in relation to human resource requirements, then the priorities for the industries – which it should be recognised are in some cases already been pursued – are to:

- work more closely with education and training establishments at both upper secondary and tertiary level to define the sector’s future needs in terms of the training programmes and courses offered and their contents, as well as providing opportunities for students to gain practical relevant experience
- make the industry more attractive to new generations of highly qualified workers, including women graduates, all of whom have many potential job opportunities open to them, by responding to their non-monetary needs and improving the conditions of employment as well as by offering competitive rates of pay
- Develop competences based around the interface between modern management techniques and the use of hybrid technologies
- Plan for the continuing transition from old to new ways of working, use older workers effectively and extend their employment in order to derive the maximum benefit from them

More detailed and specific choices in this context are as follows.

### Making the industry more attractive

Recognise that potential recruits have other career options open to them and encourage industry bodies to promote a positive, forward-looking, image for the industries as a whole

Underline the central role the industry plays in the economy in terms of both generating income and the indirect jobs which are dependent on it and increase awareness of its success in both export markets around the world and in competing with imports on the internal market

Ensure that working conditions in general are at least equivalent to those in service sector firms

Develop flexible working arrangements, which will help firms to recruit a more adaptable workforce at all levels

Develop partnerships and social dialogue so as to overcome the old image of a dispute-ridden battleground for traditional employers and trade unions.

### Improving gender balance

Take appropriate action to attract more women into the industry not only because they represent the main source of labour force growth in future years in many parts of the EU but also because they represent an important means of meeting skill needs which at present is being under-exploited

Ensure that career opportunities for women, as well as rates of pay, are at least as favourable as those for men

Develop systems of work organisation that are family-friendly so as to attract women, and men, who need to balance employment and family responsibilities.

### Developing wider competence

The industry is developing new working systems based on the integration of technology, work organisation and high quality human resources. There is a need for industry, governments and education establishments alike to ensure that this is reflected in the education and training programmes offered at upper secondary and tertiary level, by business schools and as well as engineering, science and technology departments

Research relationships – between universities, research centres, and firms and business organisations – need to be strengthened at national, regional and local level to reflect the broad changes taking place in the industry, but also to address specific challenges related to local industries

While education and training systems are likely to remain nationally focused, there is an urgent need to draw on the different strands and experiences in Member States in order to identify best – or at least good – practice and seek to replicate it in other countries, or more realistically to borrow the most important features.

### Strengthen the focus on energy

The EU industry is at the leading-edge in terms of developing renewable energy technologies and products. This provides a particular focus for a number of sub-sectors and should be suitably targeted

The industry is a major energy user and could gain by further promoting energy saving and eco-friendly methods in the context of debates about energy use and climate change.

**Age management in a changing industry**

If it is not to act as a constraint on growth, there may be a need to slow the pace of exit of older skilled workers given the difficulty of replacing their skills

Training in traditional skills takes time but, in specialist parts of the industry, more consideration could be given to encouraging older workers to pass on their skills and know-how to younger workers

**Tackling skill shortages in a coherent way**

Coherent long-term methods and polices are needed at appropriate levels – national, regional, local and sector as well as in individual firms – which takes due account of the often lengthy period required to train people to perform particular tasks, in order to anticipate and respond to prospective skill shortages in a timely and effective way.

**Tackling national and European education and training weaknesses**

Across the EU, there is a need to ensure that national education and training institutions have the capacity to provide the skills and competences required by the industry, based on assessments of future needs of the kind undertaken here

Evolving scenarios of future skill requirements need to be regularly confronted with projections of the prospective 'output' of the education and training system of particular skills in the coming years

Companies and employees need to be actively involved in the design and provision of education and training, to have close links with schools, technical colleges and universities, and to advise on the content of programmes.

A similar need extends to continuing vocational training, which is essential for workers to extend and update their skills as requirements change, but where available evidence suggests that it is inadequate at present

Much more attention needs to be paid to prospective demand for non-graduates, especially where sector-specific skills and competences are required, including the potential of new forms of apprenticeship

Cooperation between employers and employees in addressing future needs to become mainstream practice, with the technical support of independent research bodies

Member States with under-developed, or more precisely not sufficiently focused, national education and training systems need to take corrective action if the companies located there are not to suffer an increasing disadvantage in both internal EU and global competition

The issue of the transferability of qualifications and of mutual recognition needs to be re-addressed at EU level with a view to long-term progress.

# Part 7 – Main outcomes and recommendations

The electro-mechanical engineering sector has been highly successful in global markets over the past decade. However, as a largely capital goods industry, its output will be particularly badly hit by the current down-turn, which could lead to substantial job losses in the short-run.

Moreover, wide-ranging structural changes - embracing product markets, technological applications, workplace practices, and the regulatory environment (notably concerning climate change and energy efficiency) – are likely to continue, and could accelerate the decline in employment if the competitiveness of the industry is not maintained.

This combination of a cyclical downturn and continuous structural changes will have a major impact on the human skills and competence requirements of those employed in the sector. The performance of the sector to 2020 will depend to a significant extent on how well the industry, and its sub-sectors, deals with the impact of the recession on its existing workforces, and how well it prepares for the post-recession environment.

It will also depend, however, on whether regulatory changes at EU level, notably the opening up of energy markets, work to the benefit of EU-based companies, and on whether the EU authorities recognise the importance of the sector for the EU economy as a whole (and not just for those Member States who specialise most in engineering) and develop a more pro-active EU-wide policy regarding its development than has been the case in the past.

In some cases there are (theoretical) alternatives for the industry and governments to take, but in most cases, it is more a question of doing relatively more or less along well established paths.

For EU-based firms, the most important options concern their markets and their workforces:

- Do they work to strengthen their positions as global players in their respective markets, or do they retreat and become more European, national or regional players, relying on proximity to their most accessible markets?
- Do they try to retain their existing workforces in anticipation of eventual recovery from the recession, or do they retrain those employees they can, provide transitional support those employees they make redundant, and work to attract more graduates and professionals for the post-recession era?

For EU level authorities, the most basic requirement is to ensure that there is as level as possible a playing field at international and EU level for the industry (see box Y below). However, the EU also faces options. Does it:

- Leave national governments to do whatever they wish in support of nationally-based companies within the limitations allowed by EU industrial and competition policy?
- Recognise the strategic importance of the sector for the Union as a whole – providing over 20% of its exports of goods - and take a more pro-active stance in encouraging the transformation of groups of nationally or regionally based firms into a more coherent and competitive European industry?

In the past, despite the semblance of activity - reflected in the production of reports and the organisation of occasional conferences - the industry approach can be broadly characterised as reactive and the EU authority attitude as inactive. In the face of the challenges now faced, as evidenced above, the industry and the EU authorities will both need to become much more pro-active if the industry is to continue to make the contribution it currently makes to the prosperity of the EU economy.

**BOX – General Government policy responsibilities that impact the sector**

**Economic policies**

- Global competition rules
- Internal market competition rules, with removal of obstacles to competition, including state aid distortions
- Financial assistance for regions with relative low living standards
- Support for converge of new Member States towards EU average income and employment performance levels

**Industrial policies and scientific**

- Support for EU-wide Research and development
- Protection of intellectual property rights
- Assessments of the performance of EU industries in global markets

**Environmental policies**

- Energy efficiency in production processes, supplying industries, and the production of raw materials
- Transport policies
- Policies regarding the use of alternative energy sources, and the development of renewable energy sources

## Strategic choices for the industry

Whatever the impact of levels of employment of the current downturn, companies will need to invest afresh in human resources over the medium to long-term if they are to, not only to replace an ageing workforce in existing categories of jobs, but also develop the qualitative workforce competences adapted to changing technological, workplace organisation and market requirements.

It remains unclear how rapidly new operational approaches - combining modern management techniques with the use of new hybrid technologies - will spread across all the industry or remain limited to certain sub-sectors. Nevertheless, the pace of change and the impact of demand for different competences is clearly going to be rapid, as it has been in recent years.

**BOX – Strategic considerations concerning skills and competences**

A key challenge for the future is **the ability of companies to embrace technological advances** and combine them with a parallel **development of the skills and competences** needed to harness and exploit these advances in whatever market circumstances they face.

In this context, there is a need to recognise that the sector has frequently faced **skill shortages** in periods of high growth, particularly in relation to qualified engineers and computer-related activities. As in previous downturns, these shortages have been significantly reduced (apart from specific types of jobs in particular countries), but they still remain and are likely to re-appear as recovery occurs.

The scale of the job losses that are likely to occur during the downturn, and which could be substantial, will add to the industry's problems. The industry itself recognizes that 'the image of the industry is often poor and does not reflect either the reality of what Mechanical Engineering has become today, its world class leadership, its potential as an employer and its increasing innovation both for products and work processes' as reported in the the Engin Europe report.

The industry also acknowledges that it has faced difficulty in the past in attracting well qualified workers, especially the most highly educated, as reflected in the number of engineering graduates who seek employment outside of the engineering industries. If falling employment levels are interpreted by potential entrants as suggesting **uncertain long-term career prospects**, then these difficulties are likely to be reinforced. If, for these or other reasons, the industry is unable to recruit qualified engineers, professionals and skilled workers in sufficient numbers, then the **recovery and competitiveness of the industry** as a whole could be threatened.

**Consequences:**

There is a need:

- **to attract and recruit qualified people and retain them –** which depends on the image of the industry, the work environment and organization, and the overall package offered to employees;
- to ensure that there is a **sufficient pool of people with the requisite qualifications to recruit from** – which depends on sufficient people being attracted to study engineering and related disciplines;
- to ensure that **education and training systems and courses provide the skills and competences that the industry requires** and will require in the future;
- for the **industry itself to provide the more specialist training** necessary to ensure **life-long development of workforce competences** in line with technical, scientific and organizational changes in the industry.

**Shared responsibilities**

The industry, as well as education and training systems, has a significant part to play in addressing skill needs. However, more attention needs to be paid to the extent to which the **responsibilities** for ensuring an adequate supply of labour are shared between the industry, the social partners, governments and individuals.

Views concerning the most appropriate balance of responsibilities tend to differ across the EU according to the **systems of education and training** in place at national level, and the **attitudes and expectations** of the different parties

**Strategic choices**

However the responsibilities are shared, the strategic choices relate to a **range of issues**:

- ways of improving the **image of the sector** and the **quality of the working environment** in order to attract more highly qualified employees, including women;
- the extent and form of **cooperation with universities, colleges and other teaching establishments** at upper secondary as well as tertiary level to try to ensure that their output matches the needs of the industry;
- the extent of provision of **practical workplace training** for students as part of these systems;
- ensuring that the **updating of specific skills and competences** of the work force in the industry keep pace with the needs of the industry as technology advances;
- the extent to which this implies **cooperation between firms and social partner involvement** and **action at a European as well as national or regional, level.**

**Implications for education and training system** as well as **governments** relate to:

- the importance of expanding the **output of engineering and science graduates** by encouraging more people to take the courses concerned;
- the need to develop **managerial skills** among engineering and scientific graduates as well as to develop more **specialized competences and skills;**
- the need to encourage the **study of technical and scientific subjects at all levels of education** so as to expand the number of young people opting to follow an engineering or scientific career path;
- the importance of **working closely with local companies, employer associations and trade unions** to ensure the relevance of the courses provided and their content;
- the need to change the **image of engineering, and manufacturing more generally**, in relation to other fields of study and encourage young people to have a more positive attitude towards it;
- the need to provide more **practical, vocationally-oriented options** as alternatives to more general education programmes of study;
- the need to increase the **practical and vocational content of more general education programmes** of study;
- the need to ensure a reasonable level of **ICT competence** among all students and trainees.

In this context companies need to:

- Work together at EU and national level to improving the public image of the sector and address concerns about the quality of the actual working environments in order to attract more highly qualified employees, including women, and in order to attract a larger share of university engineering graduates.
- Work closely with universities, colleges and schools in their own localities in order to promote greater diversity of university level qualifications, so as to develop more hybrid qualifications in engineering and management alongside more highly specialised engineering qualifications, at both graduate and post-graduate levels.
- Work closely with universities and colleges, on the one hand, and regional and local authorities on the other, to promote engineering and science to schools and to expand arrangements to provide more places for practical work experience for students at all levels.
- Support the development of the European qualifications framework – whose aim is to make qualifications more ‘readable and understandable’ across different countries and systems in Europe, while continuing to work on raising and developing national

standards, as part of a wider effort to build new qualifications to match emerging competence needs, including key elements such as ICT.

- Promote the modernisation of apprenticeship schemes where appropriate, including in countries where they are absent or under-developed.
- Work with local and regional partners (government representatives at all levels and their agencies, employees and trade unions, universities and training agencies, as well as other businesses in the locality and sector) to address specific industry and business concerns, including access to, and finance for, training.

## Strategic choices for governments

The heavy concentration of European firms in a limited number of regions seems likely to persist, but should this be seen as a source of strength or a weakness for Europe? Gains from concentration - local networks of suppliers, links with universities and research centres, availability of skilled labour, political support, etc – need to be seen against the risks to the regions concerned – including vulnerability to job losses during economic downturns, and the possible long-term decline of the sector.

Will the gains from concentration in particular localities limit the scope for relocation of production, or particular parts of the production process, to the new Member States and to low costs countries outside the EU? Or will the engineering excellence of established EU companies and their workforces, with their emphasis on product and service quality and on technical innovation to meet the needs of end users, limit the scope for relocation in any case?

Likewise, should the increased possibility of relocating the more labour-intensive activities and sub-sectors to lower cost countries be seen as a threat to the continued strength of the sector in the EU, or should it be seen as a means of enabling EU15 firms to concentrate more on the higher value-added segments of the market, where it is likely to be the most competitive, as and until productivity levels in the new Member States catch up?

More generally, are the prospects of different Member States within the EU likely to converge or diverge, such as between Germany and other counties or between EU15 countries and the new Member States?

In particular, are the new Member States at risk in future years of losing large parts of their newly acquired employment because of the continuous search by companies who are competing in price-sensitive and technically relatively mature sectors – such as many consumer ‘white goods’ or motor vehicles - for low cost locations? Or will the industries in the new Member States also develop their capacities in ways that enable them to adapt to these market pressures?

### Specific support at national level

A wide range of supporting actions by national and sub-national governments can be helpful in managing the sector’s transition over the coming decade and beyond:

**Workforce support**

- Provide specific support to firms that retain/retrain their workforce
- Provide training investment for the development of future skills

- Encourage science and engineering in schools and universities
- Revive and modernise technological universities

**Markets**

- Promote globalisation and the contribution the engineering sector has made to raising EU living standards
- Promote competition, including especially the opening up of the internal energy market
- Support market research that can better indicate future directions for the EU sector

**Technology**

- Support R&D especially in relation to the use of new materials
- Support energy saving, eco-friendly, and efficiency initiatives
- Support innovation and entrepreneurship in general in the sector

**European level**

- Develop economic and market perspectives for the European industry
- Review and monitor the geographical distribution and development of the European industry
- Encourage Member States to cooperate across all areas of their activities, but especially in relation to employment and work organisation and education and training

## Implications for national and regional education and training institutions

The most pressing human resource problems that education and training institutions have to recognise with respect to the electro-mechanical sector are:

- the industry is failing to recruit enough of the engineering graduates who leave universities with engineering or other appropriate qualifications – mainly because the industry is (probably rightly) seen as relatively unattractive (poor work locations, not gender friendly, limited career prospects, cyclical businesses)
- engineering and scientific graduates emerging from university level institutions do not necessarily have the right combination of skills and competences needed, although most countries have courses that combine technical and scientific knowledge with managerial content and experience
- most crucially, while there are ‘good practice’ examples from specific companies or localities, there are no clearly developed and articulated national, let alone European, indications of how the new kinds of intermediate level technical and practical competences and skills that are required in a ‘post-manual work’ workplace should be developed, taught and certified.

In respect of this latter concern, what seems clear is that the experience of the past – in which national firms, large and small, build loyal, and relatively immobile, workforces through apprenticeships (as in Germany) or learning on the job (Italy) – is not necessarily the best, and certainly not the only, basis on which to build for the future.

The shift in the electro-mechanical sector towards more jobs for managers and professionals is increasing the demand for people with relatively higher levels of education, while the shift away from manual workers, and semi-skilled workers in particular, is reducing the demand for people with vocational training qualifications. Moreover, there has been an increase in education levels within occupational groups, which has reinforced these tendencies.

At the same time, differences in the educational background of professionals working in the sector vary enormously between Member States – with, for example, only 15% of engineers and 20% of non-engineering professionals in Italy having tertiary level education compared with over 60% and 40% in France and Germany respectively.

In these circumstances, and in the absence of any obvious current convergence between Member States in terms of systems and patterns of relevant higher education and vocational training provisions, the practical guidelines for public authorities, universities, and colleges in relation to the provision of education and vocational training to potential entrants to the sector have inevitably to be general for the moment, namely:

- to raise the output of engineering and science graduates by encouraging more people to take the courses concerned (and to work in the sector afterwards)
- to encourage the study of technical and scientific subjects and mathematics throughout all levels of education, beginning at the earliest possible age, so as to expand the number of young people potentially able to follow an engineering or scientific career
- to work closely with local companies, sector associations and trade unions to ensure the relevance of courses provided and their content, where these are related to local needs
- to contribute to changing the image of engineering and manufacturing more generally in relation to other fields of study and change the attitude of young people towards it
- to develop managerial skills related to the application of scientific and technical knowledge for non-technical as well as technical students
- to provide more practical, vocationally-oriented options as alternatives to more general education programmes of study

## Specific recommendations

Given the strategic significance of the sector for EU trade and competitiveness, and hence for European economic performance overall, there are clear potential benefits to the development of a more strategic EU-level approach to the industry, including, in particular, the development of a European approach to education and training provision relevant to the sector.

In view of the enormous differences in national systems and provisions that currently exist, however, the prospects for achieving a progressive convergence of national education and vocational training systems with regard to relevant engineering qualifications are poor without active support from the highest political level.

The industry has to become *pro-active* rather than *reactive* in response to the challenge of modernising its workforce in the face of the forces of technological advance and globalisation, as do national governments and EU authorities who have been largely *inactive* with respect to these issues.

While the EU authorities and national governments address general economic, industrial and environmental policy issues that affect the sector, they have done little that specifically recognises the sector's importance in term of the EU economy, accounting as it does for more than 20% of EU exports.

This weakness is particularly apparent in relation to human resource issues relating to employment, education and training. Yet no real action has been taken. The most recent industry produced reports speak mainly about the need for more graduates and then in the most general of terms.

There are three basic explanations for this lack of sharp focus. First, the industry embraces a wide range of diverse sectors and subsectors with different features and interests. Secondly, national education and training practices are deeply entrenched in national institutional arrangements, which are complex, very specific and subject to only limited EU-level influence. Thirdly, the sector's activities are very unevenly spread across the Union, further serving to discourage common action.

There are, nevertheless, many common concerns in Member States, given the parallel trends in many parts of the industry. These include the need to upgrade skills, the emergence of demands for new competences, the difficult of ensuring an adequate flow of engineering graduates and uncertainty about the best way to develop the kinds of intermediate level competences and skills that are needed in a 'post-manual workplace' pattern of production.

## A pragmatic way forward at EU level

In the case of graduate qualifications, progress is being made in their general reconciliation across Member States, and this is proving valuable in many occupations and areas of work, although engineering represents a particular challenge given that what constitutes a 'qualified engineer' is an issue of unresolved debate *within* countries, let alone between them.

Despite such difficulties, actions are urgently needed, but without setting up elaborate strategic plans that take decades to develop, negotiate, and implement at EU and national level. The proposal is, therefore, for the EU institutions to put the maximum effort into 'open method of co-ordination' style approaches, in which governments, employers and trade unions and employees, explore national and regional experiences in a spirit of mutual learning, while using 'peer group' pressure to encourage the adoption of best, or at ;east, good practices.

This would, eventually and progressively, lead toward convergent solutions, but only when the industries themselves (notably the multinational and global companies) come to recognise the benefits of building a more competent and adaptable European workforce on which they can all draw. A body of verifiable knowledge, however, has first to be established about the situation on the ground in all its variety and diversity.

Results need not take a long time to emerge. The advantage of mutual learning is that good ideas are likely to be picked up quickly by those who can see the benefit and bad ideas shunned by those who see their consequences.

While the EU authorities should take the lead in fostering these exchanges of experience, the responsibility for action should remain, where it currently is, at national level. In this context, realistic assessments of the extent to which successful national practices and arrangements can be effectively transposed across borders without fundamental changes in overall systems need to be made, along with assessments of the wider conditions for success – including the capacity of social partners and local and regional level agencies and authorities to provide support.

Moreover, while the focus of this project is on the impact of structural changes on skills and competences, any actions that public authorities take that combine the pursuit of upgrading skills with managing the employment and social consequences of the current economic recession in a socially-acceptable way – for example by coordinating support of relevant government agencies at local and regional level – are likely to be particularly welcome.

# Annex 1: EU level co-operation concerning the development of European qualifications and competences

This annex draws upon published reports and position papers, and contributions made during the Expert Workshop 3-4 November, 2008.

## Social partner participants

National social partners from both the industries covered are fully represented at EU level.

On the employers’ side, the main representative bodies are Orgalime and CEEMET.

**Orgalime** is the European federation representing the interests at the level of the EU institutions of the European mechanical, electrical, electronic and metal articles industries as a whole. Its member federations directly or indirectly represent some 130,000 companies of an industry that employs over 11 million people. These companies are overwhelmingly small and medium-sized enterprises.

**CEEMET**’s mission is to represent, promote and defend the social policy-related and industrial relations interests of the employers in the metal, engineering and technology-based industries on the European level. Its members are national employers’ organisations and federations, representing 200,000 member companies across Europe, the vast majority of which are SMEs, providing some 12.7 million jobs and covering all products within the metal, engineering and technology-based sectors.

On the trade union side, the main representative bodies are the ETUC and the EMF.

The **ETUC** exists to speak with a single voice, on behalf of the common interests of workers, at European level and represents 82 trade union organisations in 36 European countries, plus 12 industry-based federations. Its prime objective is to promote the European Social Model and to work for the development of a united Europe of peace and stability.

The **EMF** is an umbrella organisation representing 72 metalworking unions (and 4 associated organisations) from 33 countries with a combined total of 5.5 million members. One of the EMF’s main aims is the deepening of the social dimension in the process of European integration. The EMF contributes to this by representing the economic and social interests of workers in the metal industries at European level and by feeding EU policy initiative in the field of social affairs, industrial policy and other policy areas (environment, education and training, research and development) related to sectors such as mechanical engineering and automobiles.

## Reports, positions and activities

The European Commission has recently produced two major reports in relation to the electro-mechanical sector:

- EnginEurope – for a thriving European Mechanical Engineering Industry in the 21st century
- Electra – we can do it: twenty solutions for growth and investment to 2020 and beyond

Both these report are the product of high-level discussion groups and focus on challenges and policy recommendations at EU level.

**Engin-Europe**

In terms of education and training, the EnginEurope report states the following:

‘As a leading supplier of innovative products and customised solutions, Mechanical Engineering companies depend heavily on having skilled staff at all levels – workers, supervisors, engineers, service staff, etc. There is especially an urgent need to create absolutely top class education facilities for talented natural science and Mechanical Engineering students, with adequate funding which aims to match or exceed that of the top American and Asian elite educational institutions.’

In order that the Mechanical Engineering Industry can meet the major challenges, a number of Recommendations are made:

‘Europe must become an attractive place for the most talented, high calibre students. This requires a high standard of education and state-of-the-art laboratory equipment. To accomplish these goals, adequate tuition fees have to be raised and competition between universities should be encouraged’.

‘To motivate also highly educated, first class non-European engineers to work within the European Mechanical Engineering sector, easy access and proper working conditions need to be there. The image of the industry is often poor and does not reflect either the reality of what Mechanical Engineering has become today, its world class leadership, its potential as an employer and its increasing innovation both for products and work processes’.

‘As Mechanical Engineering products become ever more complex and accompanied by an increasing service offering – so most companies expect an increasing demand for skilled staff at all levels in the coming years. Even today, the number of university graduates is generally too small to meet the demand of the industry. The trend towards early retirement is making the situation even worse. From 2010 onwards, demographic trends in Europe will further intensify the shortage of skilled workers and engineers’.

‘In education, pupils take their teachers as an example to follow. Therefore, it is essential that teachers are aware of the importance of technology for society as a whole. Teachers play a vital role in promoting a positive and open-minded attitude of their pupils towards the Mechanical Engineering sector. However, today teachers in their own education receive only limited information on the jobs that industry offers and on the industrial environment in general. To overcome this issue, there is a clear need to revise the curricula of teacher training courses’.

‘While unemployment remains stubbornly high in many countries, at the same time Mechanical Engineering companies are desperately seeking high calibre apprentices, qualified workers, skilled technicians and engineers and researchers. This essentially arises from the fact that, in the increasingly hi-tech environment of the industry, there is a mismatch between the skills that companies need and those that are available on the labour market:

- In the case of Germany, a study by the VDMA from 2002, shows that there is a total annual demand for 5000 engineers in Germany and that the number of engineering students will not meet the medium term demand for engineers.

- A labour survey of Technology Industries of Finland evidences that the difficulties to recruit qualified staff have increased since 2004. At the end of 2005 recruiting difficulties were reported by 47% of companies, with shortage that have topped the list for over 10 years: welders, metal processors, mechanics and engineers'.

'Both the authorities and the social partners must work together to ensure the availability of the skilled staff which the industry will need to provide these services'.

**Electra**

The Electra report, which focuses particularly on the impact of increased energy efficiency on the electrical and electronic engineering industries, includes a section on education and skills, where it states:

'Skills shortage is a major point of concern for the electrical engineering industry which relies on highly skilled staff to develop its products. Engineers represent a higher percentage of employment than in other manufacturing sectors and the industry is finding it increasingly difficult to meet its needs for these and other skilled staff. A pro-active policy to ensure the supply of skilled labour is therefore key to the industry's long-term success.

The following recommendations should contribute to that:

- Accelerate the transfer of know-how from research institutes and universities to businesses: this is today insufficient.
- Aim at achieving that all EU countries should send at least 50% of students through tertiary education.
- Aim at attracting at least 25% of tertiary education students into technical, engineering and science education.
- Provide for the possibility for equivalence of all technical degrees across the EU; implement science and engineering bachelor and master system across all EU countries, foster scientist and student exchanges across EU countries.
- Attract engineering talent from abroad into the EU, including by starting a call-back programme for EU engineers and scientists now working in the U.S.A. or elsewhere outside the EU.
- Encourage engineering apprenticeships
- Initiate regular EU excellence competitions of EU science and engineering schools based on education results (not research).
- Create transition points between technical education and bachelors (university) education.

There are a number of centres of excellence in different industries across Europe. However, in order to maximise the chances of achieving real economic benefits, more collaboration and a critical mass in innovative clusters is necessary. Regional specialisation is important for industries to grasp the full benefits of the internal market through economies of scale.'

## EU progress towards EU-wide qualifications

The EU has established an on-going programme of work to develop more compatible education and training arrangements within its borders, including through the Bologna process established in 1999 with an initial target date of 2010, in line with the Lisbon strategy.

CEEMET produced a strategy paper on ‘Strengthening the competitiveness of the European Metal, Engineering and Technology-based Industries’ in 2004, and submitted two position papers in 2007 on:

- The European Qualifications Framework for Lifelong Learning (EQF)
- The European Credit System for Vocational Education and Training (RCVET)

The EMF held a Conference on ‘Qualifications for Europe – cross-border mobility through education?’ in 2008.

In 2009, CEDEFOP produced a new report in 2009 entitled ‘Continuity, consolidation, change – towards a European era of vocational education and training’, following a 2008 report on ‘Future skill needs in Europe – focus on 2020’.

### CEEMET Position

CEEMET argues that one of the most important challenges we face in Europe today is equipping our current and future workforce with the skills to compete in the global market place. Our strength lies in skills, quality and innovation, requiring high quality vocational and occupational training, including the development of and support for apprenticeship schemes.

This must be supplemented by ensuring a better orientation of young people towards industry - an issue which is becoming increasingly important due to demographic changes.

CEEMET is committed to life-long learning and is involved in:

- EQF - European Qualifications’ Framework
- ECVET - European Credit System for Vocational Education and Training
- Adult learning
- Anticipation of skills

In its 2004 policy paper, CEEMET took the position that:

‘It is vital that our workforce is equipped to meet the needs of companies and the challenges of both globalisation and ever increasing technological changes. This can only happen through the provision of high quality vocational and occupational training, including the development of and support for apprenticeship systems. This must be supplemented by ensuring a better orientation of young people towards industry which is now becoming increasingly important due to demographic changes.’

This report also expressed the wish to ‘see all the relevant stakeholders encourage and invest in a commitment to lifelong learning. It is a dangerous fallacy to suppose that people who have successfully passed through the school and/or vocational training or university system have been equipped with the necessary knowledge and skills for their entire working life. For their part, employees will increasingly have to recognise that the need for ongoing training and development is the key to achieving more secure and enriching jobs.'

This general view has been reflected in more specific discussions on the development of EU qualifications.

### *CEEMET on EQF*

According to the Commission, the EQF shall "act as a translation device and neutral reference point for facilitating a comparison between qualifications across different education and training systems and to strengthen co-operation and mutual trust between the relevant stakeholders". However, the CEEMET paper underlines the need for a common understanding of the principal technical terms used as a prerequisite for further progress.

CEEMET welcomes the main goals of the EQF, namely a greater transparency and improved comparability of the qualifications in the different European vocational and higher education systems, but underlined that EQF can only be of indicative and voluntary nature.

CEEMET welcomed the 'learning outcomes approach' but stressed the need to classify qualifications according to results and not the duration of the studies, with results assessed and validated. In this respect, CEEMET was favourable to the integration of the Bologna process in the EQF although it saw some difficulties in this integration since the systems are based on different approaches.

As to terminology, CEEMET expressed concern about the proper use of the term 'competence'. In CEEMET's view, it is not clear which 'competences' are addressed since, for employers, the term 'competence' is defined as 'the proven/demonstrated - and individual - capacity to use know-how, skills, qualifications or knowledge in order to meet usual - and changing - occupational situations and requirements'.

The problem is that levels of autonomy and responsibility are seldom evaluated before delivering a qualification/certification, especially when this is done at the end of initial training of younger people. In some countries the assessment systems adopted by the schools or universities includes elements of competence based assessment organised jointly with the employers, but in many countries the assessment systems tend to focus on skills and knowledge only.

In general, CEEMET felt that some more experimentation of the EQF would demonstrate its suitability as an operational and neutral device for future development. The use of the EQF references implies an evaluation of the educational programs/diplomas at national level for the establishment of NQF. This could result in an under/over-evaluation of qualifications by reference to the EQF or in an under/over-evaluation of some forms of education/training compared to others in the NQF. It is also important that the EQF implementation does not lead to a reduction of flexibility of the educational programs to adapt to labour market needs.

Finally, CEEMET remarked that, since the social partners had been little involved at European level in the preparation of the EQF, it felt that the qualifications would be better accepted on the labour market if the social partners at national level were involved in its definition, and in the decision of classification within the NQF.

### *CEEMET on ECVET*

CEEMET recalled that transparency, and the comparability of occupational qualifications and skills, are important tools for increasing the geographical and occupational mobility of workers, both at national and EU level. They contribute to releasing the full potential of the free movement of workers and the free provision of services, which was in the interest of both employees and companies - employees can show their capacities and skills, and employers have access to qualification profiles of individual persons.

CEEMET shared the European Commission’s view that any tool to improve transparency of occupational professions should be voluntary and based on the principle of respect of the variety of the educational systems, and recalled that ECVET only addresses learning *processes,* and is not a tool of immediate use for companies.

The most important objectives and functions of ECVET is to allow individuals to have learning outcomes acquired abroad taken into consideration for the purposes of issuing a qualification in its country of origin, whether the ‘learning outcomes’ had been acquired through formal, informal or non-formal learning processes. CEEMET welcomed this approach, which is essential for companies and necessary to make ECVET compatible with EQF, and argued that, in order to ‘keep the doors open’ between VET and higher education, it is crucial that ‘the learning outcomes’ approach applied at all levels of the education and vocational systems.

In practice, the concrete result of the ECVET will depend very much on the way it will be implemented. In a positive scenario, it could provide a better link between the educational system and the labour market, and create pathways between vocational training and higher education. In a negative scenario, it would create rigid boxes with criteria/definition of qualifications and prevent the necessary flexibility of the educational/training systems.

Overall, flexibility and adaptability are important preconditions for occupational vocational systems and skills profiles to be able to cope with ever more rapidly changing demands of production methods and qualification needs. Doubts were raised, however, by CEEMET about the feasibility of the ECVET concept, noting that it implies a partnership between ‘competent authorities’, which differ enormously from country to country, reflecting the huge differences that exist between national vocational and further training schemes.

On one hand, while some flexibility is required, some coherence is also needed in order to guarantee quality at all stages (training, evaluation, validation, recognition).

CEEMET supported the objective of enhanced mobility and improved transparency of qualifications and welcomed a concept promoting the ‘learning outcomes’ approach, and considered that ECVET could be a useful and secure tool for the development of transnational partnerships if correctly implemented. However given the number of questions raised, it believed that it was necessary to undertake pilot projects and studies, and to assess and discus their results, beforehand.

### EMF position

Competence development and lifelong learning are central elements of the integrated EMF approach to developing employment, employability and competitiveness in the European metal industry. Education and training have also become a central element of the anticipation of change in the manufacturing industry in Europe and lifelong learning is seen as a horizontal approach linked to industrial policy, collective bargaining, social dialogue and company policy.

In its view, however, ‘Outsourcing and use of contract work has become widespread in the (mechanical engineering) sector, thus contributing to a deterioration of working conditions in some enterprises and to a lesser attractiveness of a sector which has more and more difficulties hiring new recruits and skilled engineers’.

The EMF has long supported life-long learning for employment and competitiveness in the European metal worker sector and, in the beginning of 2008, the EMF undertook a major European Conference on ‘Qualification for Europe – Cross-border mobility through education’ with a range of speakers from trade unions, companies and universities addressing the issues of EQF and ECVET.

## Conclusions concerning European developments

What is evidence from the above is that:

- There appears to be a considerable gap between the diversity that currently exists across Member States regarding educational and training practices with respect to electro-mechanical engineering, and the European Commission and Council aspirations with respect to the establishment of a Europe-wide system of qualifications to permit and encourage EU-wide mobility.
- The EU level social partners in the electro-mechanical sector are committed to addressing issues of skills and qualifications, and are positive in principle regarding EU convergence (albeit with caveats). However, it is not clear to what extent employer associations and trade unions have been equally associated to European Commission initiatives, notably with regard to the production of the Commission sponsored reports, EnginEurope and Electra.
- While the EnginEurope and Electra reports fully recognise that qualifications requirements are rising in the industry, and that there is an urgent need to increase the supply of engineering and science graduates (and ensure that they enter the industry rather than disappear elsewhere), relatively little is said about the non-graduate section of the workforce, which will remain significant in size, and which will also be important in determining the industry’s future.

More generally, relatively little appears to be being done at EU level to address the present labour market situation facing the industry. The European qualifications framework (EQF) should create ‘a common reference framework which links national qualifications systems, acting as a translation device to make qualifications more readable and understandable across different countries and systems in Europe’, as stated in the 2009 Cedefop report, but this does not address many current concerns, which could persist for many years.

National education and training systems vary between Member States in most industries but, in the case of the electro-mechanical industries, inter-country differences are particularly significant reflecting, not only general national differences, but the considerable regional/national imbalance in the concentration of these activities, as reported elsewhere, and the importance of major employers as suppliers of training.

A similar situation existed with relation to national government labour market policies until the development of the ‘open method of co-ordination’ techniques by the European

Commission and Council in recent years – methods which take as given national arrangements, but which enable these different systems to be compared and contrasted in practical ways, with ‘peer group’ pressure working to ensure that ‘mutual learning’ get translated into action.

The situation is somewhat different in industry, where education and training arrangements may be seen as part of the competitive armoury of companies and countries, but it would nevertheless seem appropriate to try to address the electro-mechanical industry’s immediate qualifications, skills and education and training concerns through a similar ‘open method of co-ordination’ style approach, possibly organised jointly by governments and social partners.

# Annex 2: Participants at Expert Workshop 3-4 November, 2008

Chair: Jean-François Lebrun: European Commission, DG EMPL

Enrico Gibellieri: European Economic and Social Committee

Isabella Biais: CEEMET, Council of European Employers of the Metal, Engineering and Technology-based Industries

Pierre Chartron: UIMM, Union des industries et métiers de la métallurgie

Caroline Holmqvist: CEEMET, Council of European Employers of the Metal, Engineering and Technology-based Industries

Wolf Jäcklein: FEM/EMF, Fédération Européenne des Métallurgistes

Susanne Krebs: VDMA, German Engineering Federation, European Office

Georg Matzner: ORGALIME, European Engineering Industries Association

Georg Sashov Milushev: FEANI, European Federation of National Engineering Associations

Mariette Wennmacher: UEAPME, European Association of Craft, Small and Medium-sized Enterprises

Manuel Hubert: European Commission, DG EMPL

Patricia Pedelabat: European Commission, DG EMPL

Radoslaw Owczarzak: European Monitoring Centre for Change, Eurofound

Terry Ward: Applica

John Morley: Applica