



Investing in the Future of Jobs and Skills

Scenarios, implications and options in anticipation
of future skills and knowledge needs

Executive Summary Non-Metallic Materials



Authors:

A. van der Giessen (ed.) (TNO Information and Communication Technology)

Dr F. van der Zee (ed.) (TNO Innovation and Environment)

Dr G. Gijssbers (TNO Innovation Policy Group)

D. Maier (ZSI Centre for Social Innovation)



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TNO Netherlands Organisation for Applied Scientific Research
SEOR Erasmus University Rotterdam
ZSI Centre for Social Innovation

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Overview

This executive summary highlights the main results of the final report *Investing in the Future of Jobs and Skills. Scenarios, implications and options in anticipation of future skills and knowledge needs in the Non-Metallic Materials Sector*. Apart from analysing sector trends and developments, the study explores four plausible and distinctly different futures and their implications for jobs, skills and knowledge in the year 2020. The study is scenario-based, and is both forward- and backward-looking. It presents a variety of options and recommendations to address future skills and knowledge needs, aimed at the sector (firms, industry at large, sectoral partners), education and training institutes, policy-makers and other stakeholders.

The study should be placed against the background of the EU's renewed Lisbon Strategy for Growth and Jobs and the recently launched New Skills for New Jobs initiative. Investing in people and modernising labour markets is one of the four priority areas of the Lisbon Strategy. The New Skills for New Jobs initiative (European Commission, 2008) presents a very first assessment of the EU's future skills and jobs requirements up to 2020. The initiative aims to help ensure a better match between the supply of skills and labour market demand and to improve the Member States' capacity to assess and anticipate the skills needs of its citizens and companies.

This study appears in a series of 16 sector studies which are all based on the same common foresight methodology and uniform step-wise approach (see table). The study combines desk research and expert knowledge, and brought together various internal (project team) and external sector experts. The methodological framework that was initially developed by Rodrigues (2007) was further developed, operationalised and applied by a consortium consisting of TNO (lead), SEOR and ZSI.

Methodological framework – the study explained in ten steps

- Step 1. Identification of economic activities (sector selection)
- Step 2. Main economic and employment trends and structures
- Step 3. Main drivers of change
- Step 4. Main scenarios
- Step 5. Main implications for employment – changes by job function
- Step 6. Main implications for skills – emerging needs by job function
- Step 7. Main strategic choices to meet future skills and knowledge needs
- Step 8. Main implications for education and training
- Step 9. Main recommendations
- Step 10. Final workshop (validating, complementing, finalising)

The non-metallic materials sector – main characterisation

The non-metallic materials sector covers a mixture of industries involved in the processing of natural resources (e.g. silica sand, clay, natural stone and rock) into marketable products. Three main product categories can be distinguished, each having their own distinct production and market characteristics: (1) building materials such as cement, lime and plaster and concrete, and products thereof, as well as ornamental and building stone, in the remainder referred to as *construction materials*, (2) applications of glass and ceramics in industry and construction (as intermediary advanced goods, e.g. sanitary fixtures, insulators and technical ceramics, but also bricks, tiles and flags), and (3) ornamental and/or household glass and ceramics (as consumer goods, e.g. tableware). In line with earlier studies, construction or building materials (the first category) as well as *glass and ceramics* the second and third category taken together) have been treated and analysed as separate, but also for a large part interdependent. Because of the strong linkages of the non-metallic materials sector with the construction sector (through construction materials such as (prefabricated products of) concrete, cement and plaster, but also ceramics (bricks, tiles, sanitaryware, technical ceramics) and the dependence of still other ‘luxury’ parts of the sector on income and wealth developments (higher value added final consumer segments in glass and ceramics), the financial and economic crisis has hit the sector relatively hard. The crisis, however, also offers new opportunities to re-engineer and re-direct the course of the industry at large and opt for change towards a more eco-friendly and sustainable path. Scarcity of raw materials and energy and international competition are major external drivers. R&D and innovation, targeted policies, targeted up-skilling and addressing new knowledge needs in view of a more knowledge-intensive, creative but also increasingly automated production offer opportunities from within to bring about the needed change.

Main economic and employment trends

Value added of the sector as a whole amounted to 87 bn euro in the EU in 2006, of which 80 bn euro was produced in the EU15. Value added annual growth was - with 1.6% - slower than the 2.3% growth of the EU economy as a whole during the period 1995-2006. In the new Member States (NMS) the sector grew *faster* than the overall economy (4.5% against 3.2%). In absolute terms though value added of the NMS is still less than one tenth of value added generated by the EU-15. The glass sector accounted for 22% of total sector value added, ceramics for 21%, the cement, lime, concrete, plaster and ditto products industry for 43% and the ornamental and building stone for another 15%. Despite the relative small size of the sector in value added terms, its importance for the construction industry, other sectors like aerospace, automotive and transport (technical ceramics, glass fibres), and electrical and electronics industries (glass fibres, special glass for tubes and bulbs and the like), as well as household consumption (glass and ceramics, including decorative and handicraft products) and trade (!) should not be underestimated. External trade amounted to €8.2 bn in exports and €45.8 bn in imports, 67%, respectively 53% of value added. Imports grew faster than exports over the period 1995-2006, with 4.3% against 3.2% annually for the EU as a whole. Trade growth in the new Member States was explosive, with imports growing at a rate of 10.9%, and exports growing at 8.8% annually.

Altogether the sector accounted for about 100,000 enterprises (figures 2004), employing 1.62 million people or 0.74% of overall EU employment. 849 thousand jobs were in construction materials, 774 thousand in glass and ceramics, with 79% and 68%, respectively of these jobs located in the EU-15. Employment in construction materials in the EU grew with 0.1%

annually during the period 2000-2006, and declined with -0.3% in the new Member States. In glass and ceramics negative growth was observed in both the EU as a whole and the new Member States (-2.1% and -1.1% annually).

The majority of firms in the non-metallic materials sector (95.4%) are small firms employing less than 50 employees. 3.8% are medium-sized firms and only 0.8% are large firms with more than 250 employees. Small firms account for about 37% of all employment and their employment share has, together with that of medium enterprises, increased. This gain is quite substantial in the original EU 6 and the new Member States, but only limited elsewhere. Employment in large firms declined, and much faster than what the tiny 0.1%-point decline in the share of large firms would suggest. Most likely large firms have gained in overall productivity, by using economies of scale and substitution of labour by capital, whereas smaller firms have tended to rely more amply on labour and flexibility.

Employment, state-of-play 2006 and changes 2000-2006

Construction materials	Level 2006 (times 1,000)	Annual growth	Share in EU	Change in share
EU	849	0.1	100	0
EU15	673	0.2	79	0
NMS	177	-0.3	21	0
Glass and ceramics	Level 2006	Annual growth	Share in EU	Change in share
EU	774	-2.1	100	0
EU15	529	-2.6	68	-2
NMS	245	-1.1	32	2

Source: Eurostat/TNO. Construction materials: NACE 265+266+267+268. Glass and ceramics: NACE 261+262+263+264.

Employment trends by job function: shares (2006) and changes in shares (in%), 2000-2006

Non-metallic materials	Shares, 2006		Changes in shares, 2000-2006			
	EU15	NMS	EU	EU15	NMS	EU
Managers	7	6	7	0	1	0
Computing professionals	1	1	1	0	0	0
Engineers	6	5	6	1	1	1
Business professionals	3	3	3	0	1	0
Other professionals	5	5	5	1	-5	0
Office clerks and secretaries	9	5	8	0	-3	-1
Service workers	1	1	1	-1	-1	-1
Extraction and building workers	14	12	14	2	4	3
Metal workers	6	9	7	-1	1	0
Potters. glass making	9	15	10	-2	2	-1
Other craft trades workers	1	1	1	-1	-1	-1
Glass. ceramics plant operators	10	10	10	1	2	2
Metal. mineral plant operators	4	5	4	-2	0	-1
Drivers. mobile plant operators	9	8	9	1	2	2
Other plant machine operators	6	5	6	0	2	0
Labourers	9	10	9	-1	-8	-3

Source: Eurostat Labour Force Survey/TNO

The non-metallic materials sector is a stable, conservative sector in terms of skills mix. Most jobs are in the categories extraction and building workers, plant operators, potters (glass), and labourers. The new Member States have considerably more potters and metal workers than

the EU-15, whereas the EU-15 has more office clerks and secretaries, and extraction and building workers than the NMS. The share of women in overall employment is with 28% low compared to other sectors. Employment is dominated by medium educated employees; this is true for the EU-15 (45%), but especially for the new Member States (81%). Low educated workers, with a share of 37% in the EU-15 and only 6% in the new Member States, lost ground; decreases in the EU-15 and NMS amounted to 3 and 4% points, respectively, over the last 7 years. Almost half of all employees is younger than 40 years.

Most change during the period 2000-2006 is observed in extraction and building workers (up by 3 % points) and labourers (down by 3% points), plant operators in glass and ceramics (up by 2% points), mobile plant operators (ditto) and engineers (up by 1% point). Changes in the NMS show more remarked shifts, e.g. in the category other professionals (down by 5% points) and labourers (down by 8% points). The shift in skills structure reflects a higher capital intensity on average, i.e. substitution of labour for capital. The lower educated (‘blue collar’ jobs) lost ground overall, gradually being substituted by mid-educated. Interestingly, this change occurred most markedly in countries where the sector gained comparative advantage. Here also the higher educated gained most ground.

Participation of women in the workforce by age and education: non-metallic materials, 2000-2006

	EU		EU 15		NMS	
	Level	Change	Level	Change	Level	Change
Women	28	2	25	0	39	3
Age < 40	48	-4	47	-6	53	2
Age 40 – 50	29	3	30	5	25	-6
Age > 50	23	2	23	1	22	4
Low education	29	-6	37	-3	8	-4
Mid education	55	6	45	2	81	7
High education	16	0	18	1	12	-4
Entrepreneurs	10	n.a.	8	n.a.	17	n.a.
Definition	Level %	Total change %	Level %	Total change %	Level %	Total change %
	2006	2000-2006	2006	2000-2006	2006	2000-2006

Source: Alphametrics/TNO based on Eurostat Labour Force Survey

SWOT analysis

A SWOT analysis provides an overview of perceived Strengths, Weaknesses, Opportunities and Threats of the sector. Strengths and weaknesses are usually taken as sector-internal factors that create, respectively destroy value. For a company these can include assets, skills or resources that a company has at its disposal, compared to competitors. Similarly, opportunities and threats are external factors that can create or destroy value. They emerge from company dynamics, the industry/market at large and are driven by demographic, economic, social, technical, social, cultural, ecological or legal/political factors (DESTEP). In the table below, the results of the SWOT analysis for the construction materials sub-sector are shown. A similar mapping has been made for the glass and ceramics sub-sector (see main report).

SWOT analysis Construction materials

Strengths	Weaknesses
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<ul style="list-style-type: none">• High demand for materials• Mature industry with constant technological progress• High quality products	<ul style="list-style-type: none">• High energy intensity• Conservative industry• High transport cost over land• Increasingly subject to competition internationally due to low sea transport costs (also in bulky, low value goods)• Low domestic ('within-EU') competition
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Opportunities	Threats
<ul style="list-style-type: none"> • Increased efficiency through industry consolidation; • Recycling and re-use • Energy use reduction; energy-saving technology • Fair(er) and secure access to raw materials (Raw Materials Initiative) • Increasing substitution of raw materials • Establishing firm supplier relationships for the longer term (energy and raw materials) • Changing consumer preferences for sustainable materials (eco-housing) • Growing importance DIY (do-it-yourself) market demand, also driven by increasing 2nd home market • Technological advances leading to new materials (lightweight, energy efficient) • New product/ new market opportunities, related to R&D and innovation (e.g. nanomaterials) 	<ul style="list-style-type: none"> • Tighter environmental regulations (IPPC, ETS, REACH) and associated production cost increases as compared to competitors, especially in the cement and lime industries • Lifestyle changes and work-leisure balance shifting away from long work days and shift work → recruitment problems • Image problems (heavy and dirty industry) in relation to recruitment • Rising energy and raw material prices and increasing scarcity of certain raw materials • Changing consumer preferences for sustainable materials.

Source: TNO/SEOR.

Main drivers of change

Non-metallic materials is increasingly facing international competition and increasingly an open internationalised sector therefore, which makes it rather sensitive to developments and changes in economy and society. In total 26 drivers covering demographic, economic, social, technological, environmental and political factors were assessed for scenario construction (see for detailed results the table below). The most important drivers of change for the sector are: global competition/globalisation, availability and prices of oil, energy and raw materials, R&D and innovation, income, environmental regulation (most importantly ETS), health, safety and security regulation and IPR protection. In constructing the scenarios different assumptions regarding direction of change of these drivers were made, as follows:

- *Global competition*: Pressures for global competition are assumed to ease in a protectionist environment and increase in a climate of further continuing globalisation.
- *Availability / price of oil and energy*: both the construction materials and the glass and ceramics sub-sectors are characterised as energy-intensive industries.
- *Availability and price of raw materials*: the building materials and the glass and ceramics sub-sectors are heavy users of a wide range of raw materials.
- *R&D and innovation*: creating new products and opening up new markets are important, and hence R&D and innovation.
- *Income per capita*: slower growth of income per capita due to less global competition and a stalling global economy vs. faster growth of income per capita driven by an expanding global economy.
- *Environmental regulation*: includes reduction of energy use, and classification of substances (REACH) at European level.
- *Health, safety and security regulation*: applies to working conditions (hazardous substances, handling heavy materials), but also to consumers (e.g. lead and other substances that can harm health, e.g. through food) and includes regulations in construction.
- *Intellectual property rights protection/R&D and innovation policies*: counterfeiting in glass and ceramics form an increasing problem.

		Main drivers of change construction materials					Source: ©TNO-SEOR-ZSI. Note: * Demographic					
Category	Driver	Is this driver relevant for the sector?	How relevant is this driver for the sector?	How uncertain is this driver for the sector?	Are substantial impacts expected on the volume of employment?	Are substantial impacts expected on employment composition?	Are substantial impacts expected on new skills?	Short, medium or long run impact?			Substantial differences expected between countries?	Substantial differences expected between sectors?
		Y / N	Scale 0-10	Scale 0-10	Y / N	Y / N	Y / N	S	M	L	Y / N	Y / N
D *	Population growth (birth and migration)	Y	8	2	Y	N	N	Y	Y	Y	Y	Y
Economic	Income per capita and household	Y	8	4	Y	N	N	Y	Y	Y	Y	Y
	Income distribution	Y	6	4	Y	N	N	Y	Y	Y	Y	Y
	Outsourcing & offshoring (cement, lime industries)	Y	6	6	Y	Y	N	N	Y	Y	Y	Y
	Increasing global competition	Y	8	4	Y	Y	Y	Y	Y	Y	Y	Y
	Emerging economies driving global growth (new markets, esp BRICs)	Y	5	5	Y	Y	N	Y	Y	Y	N	Y
	Lifestyle changes impacting on work preferences (less shift work, less long working days)	Y	7	3	Y	N	N	Y	Y	Y	Y	Y
	Increasing demand for eco/green products; eco-construction materials	Y	6	4	N	N	N	Y	Y	Y	Y	Y
	Image and attractiveness - dirty and heavy industry image reducing recruitment potential, esp. amongst certain worker categories (e.g. women)	Y	7	3	Y	Y	N	Y	Y	Y	Y	N
	New products / materials (more light-weight, energy efficient, eco-materials)	Y	6	6	N	N	N	Y	Y	Y	Y	Y
	Other (Energy efficient technology, e.g. furnaces; labour saving technologies)	Y	6	2	Y	Y	Y	Y	Y	Y	N	Y
Environ-mental	Availability (and price developments) of oil and energy	Y	8	5	Y	N	N	Y	Y	Y	N	N
	Availability and price of raw materials	Y	8	5	Y	N	N	Y	Y	Y	N	Y
	Substitution raw materials and energy, recycling and re-use	Y	7	5	Y	N	N	Y	Y	Y	N	Y
Political	Trade liberalisation (WTO Doha)	Y	8	8	Y	N	N	Y	Y	Y	Y	Y
	Environmental regulation (both inside and outside EU)	Y	9	4	Y	N	Y	Y	Y	Y	Y	Y
	Safety and security regulation (customers and workers)	Y	8	2	N	N	N	Y	Y	Y	Y	Y
	Health regulation (customers and workers)	Y	8	2	N	N	N	Y	Y	Y	Y	Y

Scenarios and implications for employment

Four future scenarios have been constructed and explored: 1) *Status quo*, 2) *Conservation*, 3) *Innovation-led Growth*, and 4), *Resource Depletion* (see also figure). The scenarios depict plausible and credible futures for the utilities sector in Europe by 2020. Rather than wishful pictures of the future, scenarios are founded on drivers and trends observed and are derived in a logical and deductive way, hence making inferences about plausible future developments.

Construction, hypotheses and use of the scenarios

The scenarios apply to both construction materials and glass and ceramics. This does neither imply that future developments in both sub-sectors are to be taken as one and the same, nor that development paths between Member States need to be similar. The sectors will face different dynamics in terms of market structure and developments, while driven by similar but differently impacting drivers. The way the scenarios have been constructed enables such differentiation. Note that the demographics – ageing (less young, more retirees) – and its effects on labour supply have not explicitly been identified in selecting the drivers, as demographics in the time frame of 2009-2020 are relatively certain (i.e. predictable) and play a role across all scenarios. Education and training, which *stricto sensu* could be perceived as endogenous factors, have been excluded. They are together with a number of other strategies and/or policies discussed as solutions in response to the scenario outcomes.

Scenario I: *Status Quo*

Status quo depicts a world characterised by global protectionist tendencies leading to slow economic growth and easing competitive pressures, coupled with little progress in European harmonisation and setting of new environmental and security and safety regulations and standards shaping the sector. The EU non-metallic materials sector benefits from relatively low global competitive pressures, but it also suffers from slowing demand for European products, lack of innovation and lack of new alternatives arising for raw materials and energy problems in the medium and longer term. Furthermore, in combination with the stagnating regulatory environment with little progress made in Europe, new competitors may enter the scene. This results in a declining global position of the sector in the longer term, with protectionism meaning that the sector stays in Europe, but its base further declining.

Scenario II: *Conservation*

Conservation depicts a world characterised by global protectionist tendencies leading to slow economic growth and easing external ('outside EU') competitive pressures, coupled with European harmonisation and setting of new environmental, health, safety and security regulation shaping the sector. This means that Europe can sustain its advantage of high quality institutional environment compared to emerging competitors providing a competitive edge based on the conservation of resources at the European level. The easing competitive pressures are expected to lead to reduced incentives for firms to seek new market segments or to invest in R&D and innovation, thus reducing the rate of restructuring. The drive towards conservation may be counteracted to some extent by lower economic growth, reducing to some extent the incentives for resource conservation – unless counteracted by possible environmental regulation.

Four future scenarios for the non-metallic materials sector and main underlying drivers

Endogenous, sector specific drivers:

- Environmental regulation, climate change policies
- Health, safety and security regulations
- Intellectual property rights protection
- Quality of institutions

Strengthening environmental policies (ETS as scheduled in 3rd phase);
 Further harmonisation of health and security regulation; safety supply raw materials;
 Increased IPR protection
 Stable quality of institutions, WTO success

Exogenous drivers:

- Global competition
- R&D and innovation: new materials/products and automation
- Demand for 'green' products and input substitution/recycling
- Availability/price of oil and energy
- Availability and price of raw materials
- Income

Easing
 Slow-paced and gradual
 Driven by resource competition
 Scarcity driving up prices
 Reverting to long term average
 Growing slow

Conservation (Scenario II)

Innovation-led growth (Scenario III)

Strengthening
 Fast-paced, including automation
 Driven by resource competition

Status quo (Scenario I)

Resource depletion (Scenario IV)

Scarcity driving up prices
 Scarcity driving up prices
 Growing fast

Redressing environmental (ETS) regulation in 3rd phase, and less strict CO2 rules; no further harmonisation of health and security regulation; IPR status quo
 Stable quality of institutions, WTO status quo

Scenario III: *Innovation-led Growth*

Innovation-led Growth depicts a world characterised by further integration of markets leading to fast economic growth and continued global competitive pressures, coupled with European harmonisation of and setting of new environmental and security and safety regulation shaping the sector. This means that Europe manages to combine exploiting benefits of globalisation, sourcing raw materials and accessing production processes efficiently, while setting advanced environmental and safety standards that provide strong incentives to the industry to sustain its global innovative edge through the development of new products for a range of different markets (smart, lightweight, technical, nanotech-based, etc), the introduction of new technologies in production (including further automation and robotisation) and improvements in recycling. It should be mentioned that Innovation-led Growth is seen as the most desirable scenario by the sector (being one the conclusions of the final workshop).

Implications of scenarios: job volume changes by function, 2009-2020

	Status quo	Conservation	Innovation-driven growth	Resource depletion
Managers	-	0	+	0
IT professionals	0	0	+	-
Engineers and R&D	-	+	++	-
Accounting & Finance	-	-	+	-
Sales & Marketing	0	0	+	0
Other professionals	0/+	+	+	0
Administrative support staff	-	-	0	-
Plant and machinery maintenance and repair	-	+	0	-
Truck drivers	0	-	+	-
Skilled production workers	0	+/-	+/-	-
Labourers	-	-	-	-
Overall job change	-	+/-	+	-

Source: TNO-SEOR-ZSI. Note: - = decrease, + = increase, 0 = maintain

Scenario IV: *Resource Depletion*

Resource Depletion depicts a world dominated by rapid economic growth and international competition as a result of increasing globalisation, coupled with a lack of new European (nor global!) regulations and standards on climate change and environment. This leads initially to rapid growth based on income growth in Europe and relatively low prices which do not incorporate environmental externalities. The growth pattern is resource intensive with cheapest materials being sourced internationally, but necessarily also some high-value scarce resources such as magnesia (90% of magnesia coming from China), bauxite (Guyana) and graphite. Prices will rapidly increase for those scarce materials resulting in reduced demand. Note that the final workshop typified the resource depletion scenario as the most unlikely scenario. Yet for reasons of comparison – as ‘gloomy’ future perspective - the scenario has been kept in.

Implications of scenarios for jobs, skills and knowledge by job function

All scenarios lead to substantial change in the structure of employment and skills requirements, with the overall job volume change in Status Quo and Resource Depletion being negative, roughly stable in Conservation and positive in Innovation-led Growth (see table). To give an impression of the underlying changes at job function level, we zoom in on the example of *Innovation-led Growth*. In this scenario, the EU can only stay competitive through an increase in automation and innovation in new and improved materials and products. The EU-15 concentrate more on product refinement, and development of value added and high end / high tech products (smart new materials, sustainable applications), improved technologies (further automation, search for energy efficiency, recycling). The extraction and processing of raw materials further shifts to Central and Eastern Europe. As a result, the demand for low-skilled workers will continue to decline in the EU-15. Automation and product innovation means a further shift in workforce requirements, up-skilling and new jobs to the sector. High-skilled workers such as technical engineers and R&D personnel, environmental engineers and agronomists, designers (in ceramics and glass) and architects (in construction materials) will gain in importance. Interdisciplinary teams and ditto skills will become more demanded. Skilled workers will be in high demand, and even face competition from abroad (e.g. in China, India and the Middle East), especially in case these emerging economies also adopt stricter environmental legislation. The demand for ICT-related jobs as well as R&D personnel, engineers and environmental experts will increase; the focus on high-end and speciality products necessitates closer cooperation with customers. However, ICT-jobs may also be offshored, leaving the net balance for Europe unchanged. The number of administrative and accounting staff might decrease due to growing outsourcing and offshoring tendencies of back office activities. As products become more complex and high-end, and as new health and safety requirements are implemented, an increase in staff familiar with legal issues may rise. The number of plant and machinery maintenance and repair workers is likely to increase due to automation. The same applies for marketing personnel as new materials and products need to be introduced, advertised and marketed. Although continuing globalisation leads to growing demand for transport, the number of truck drivers may stabilise or even decrease as alternatives to road transport are encouraged. With a shift from standard and routine production to more high-value products and internationalisation, the number of managers is likely to increase. Managers of European origin may also be in increasing demand from companies and partners outside the EU.

Identification of emerging competences, skills and knowledge needs

By taking the scenarios and drivers as a starting point, logical inferences ('guestimates') of skills and knowledge needs were made for each of the identified job functions. *Skills* refer to the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualification Framework (EQF), skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). *Knowledge* refers to the outcome of the accumulation of information through learning. It is the body of facts, principles, theories and practices that is related to a field of work or study. In EQF context, knowledge is described as theoretical and/or factual. *Competences* refer to the proven ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development. Competences thus defined come actually close to what is generally understood nowadays as 'soft skills'. In EQF context, competences are described in terms of responsibility and autonomy. In the practical elaboration of future skills and knowledge needs for the purpose of this study, both have been further 'disentangled' to result into six clusters of similar and related skills and knowledge needs (see textbox below).

Future skills and knowledge needs by job function

Across all job functions soft skills will become increasingly important, especially so for high skilled professional job functions. The general trend of up-skilling across job functions is bound to continue in the coming years. Due to the changing nature of jobs, predefined technical knowledge capabilities will become somewhat less important while skills to adapt and learn new competences and life-long learning will be put at a premium. Certain knowledge – notably e-skills – will become more important. Emerging competences of higher skilled jobs mostly refer to *how* to learn, communicate, interact and adapt to changing environments in addition to a high quality education. Emerging competences in medium-educated job functions that mostly execute defined tasks and processes refer mostly to specific knowledge sets that can be taught through learning.

Overview of skills and knowledge needs identified for each job function and scenario
Knowledge ('hard skills') <ul style="list-style-type: none"> Legislative / regulatory knowledge (environmental / safety / labour / contracting); Language*; e-skills; Marketing skills; Technical knowledge; Product knowledge; Product development
Social Skills <ul style="list-style-type: none"> Team working skills; Social perceptiveness (listening / understanding); Communication; Networking; Language*; Intercultural
Problem-solving Skills <ul style="list-style-type: none"> Analytical skills; Interdisciplinary; Initiative, Multi-skilling; Creativity
Self-management Skills <ul style="list-style-type: none"> Planning; Stress and time management; Flexibility; Multi-tasking
Management skills <ul style="list-style-type: none"> Strategic & visionary; Coaching and team building; Change management; Project management; Process optimizing; Quality management; People skills crucial for collegial management style
Entrepreneurial skills <ul style="list-style-type: none"> Supplier and customer relationship / understanding; Business understanding / development; Trend setting / trend spotting
Source: TNO-SEOR-ZSI

We illustrate the key emerging skills and knowledge needs for three of the eleven distinguished job functions, including are managers, engineers and R&D, and sales & marketing.¹

Managers – Entrepreneurial skills are essential in all scenarios, but especially in the Innovation-led Growth scenario. This includes forecasting and trend-setting / trend-spotting skills but also anticipating (global) market and business development and a better understanding about customers and suppliers. Companies have to constantly keep ahead of competitors with increasingly sophisticated products, with an increasing necessity for

¹ For the Innovation-led Growth scenario only. For a summary of future skills and knowledge needs for these and other job categories, see the tables at the end of this summary. More extensive and detailed accounts on skills and knowledge needs can be found in the main report, with further differentiations made by scenario.

interdisciplinary co-operation, ability to take initiatives and multi-skilling. Growing international co-operation and dealing with new markets requires strong intercultural and language skills. Although managers are generally less involved directly in R&D activities, they need to know more about developments and industries that could provide useful input for innovation.

Engineers and R&D - Increasing interdisciplinary co-operation characterises Innovation-led Growth. Engineering is likely to become more customised, finding the best solution for special purposes and climate conditions. This requires new hard skills for engineers working in this sector, cutting through different and new disciplines. Computer-based product design and optimisation of production methods are also likely to become more important. Environmental technologies and sciences will comprise an important emergent skill category for engineers. Engineers will also be required to possess more knowledge about legal aspects and regulation affairs, especially international norms, regulations and standards and industry specific regulations. Social, managerial and entrepreneurial skills like trend-spotting / trend setting and a better understanding of customers and suppliers, team building, coaching and project management will become increasingly important. Internationalisation and a possibly higher participation rate of women require intercultural skills and 'gender competences'.

Sales & marketing - Greater emphasis on social and entrepreneurial skills is to be expected in Innovation-led Growth. Expansion and exploration of new markets will require customised marketing skills tailored to specific cultural, clients and industrial settings. A one-size-fits-all marketing strategy will not be appropriate anymore. Thus flexibility and the understanding of (individual) customers will be a great skill advantage. Other entrepreneurial skills like business development, marketing skills and even trend spotting will become very important. A considerable proportion of the product palette will exist of new products or speciality products with higher complexity and more features, sales & marketing personnel are required to possess more extensive knowledge of products and technical/ engineering factors. New computer technology, new marketing concepts and an increase in business virtualisation requires a constant updating of knowledge and skills.

Main strategic choices to meet skill and knowledge needs

In order to meet future skills and knowledge needs, apt and timely solutions – referred to here as strategic choices - are required (see table below). Strategic choices refer and relate to the medium- and longer term, even though emerging skills and knowledge needs in practice may also apply to the now and tomorrow. Essential in seeking appropriate solutions is to keep this longer time perspective in mind. Rather than focusing on one single solution, a set of linked strategic choices will in most cases be the best strategy to follow. Prioritising both in time (what first, where to follow up) and in allocation of resources (including budgetary focus) followed by further fine-tuning is a clear necessity to guarantee that skills needs are targeted and solved. Skill needs can be identified at various levels, ranging from assessments at the national or even European sector level to more precise assessments at the regional and company level. Increasingly the identification of skills and knowledge needs but also the search for adequate solutions will have to become an integral part of an overall longer-term business strategy, also for SMEs. Some solutions will be found within the company itself, e.g. through reorganising functions within or between plants, by offering (re)training trajectories or by active global sourcing of personnel. For SMEs and especially for micro-

enterprises such longer-term, more strategic human resource management often will be more difficult to organise and operationalise.

In order to address the identified future skills and knowledge needs in an encompassing and timely manner, appropriate joint action is needed by all stakeholders, including the industry (firms, sector organisations and social partners), training and education institutes, intermediary organisations and, last but not least, government at all levels (EU, national, regional and local). Collaboration is needed in order to agree on and implement a package of feasible solutions. Timely, targeted and reliable information to make decisions – i.e. adequate monitoring and analysis - is an essential prerequisite.

An example of the assessment of new skills for one job function category i.e. managers is presented in the table below. The assessment starts with six questions the answer to which is relevant for the strategic options applicable in that job function. For example, if the workforce is generally old and low-educated certain options that has specific implications for upgrading skills and competences. The table then presents 13 possible strategic options (A to M) to address skills and competence issues, assessing for each option whether it is feasible for managers, and if so, who are the key actor to take action.

Conclusions

Implications, conclusions and recommendations have been made at two distinct levels: the individual job function (micro) level focusing on options by function and those, more generally, aimed at sectoral stakeholders (including education and training) and policy-makers (meso-level). The former are summarised in the preceding table. At the meso-level a further distinction has been made between education and training and ‘other’ main conclusions and recommendations.

Conclusions and recommendations on education and training

- 1) Adapt and modernise vocational education and training (VET) and general education systems, but do this nationally rather than at the EU level;
- 2) Strengthen scientific and technical profiles in education;
- 3) Re-evaluate the position of apprenticeships in the training and education system;
- 4) Improve the provision of information on future skills and training needs to both students and trainers;
- 5) Closer collaboration between stakeholders to tackle emergent skills and knowledge gaps;
- 6) Improve and enhance the possibilities to engage in life-long learning;
- 7) Further enhance the flexibility of vocational training to address emerging training needs by modularisation, flexible and blended learning and Experience Certificates;
- 8) Actively promote multi-skilling and provide adequate training modules;
- 9) Design and provide special courses dedicated to specific sector requirements;
- 10) Supply special courses for older workers and arrange for provisions to make them stay;

- 11) Provide career guidance for labour market entrants;
- 12) Increase international and intersectoral acknowledgement of qualification certificates;
- 13) Handicraft – artisanal production of ceramics and glass in danger;
- 14) Wanted: e-skills, intercultural, language, creative, health & safety, and ‘green’ skills.

Main other conclusions and recommendations

- 1) Collaborate with all relevant stakeholders and intensify co-operation: Partnerships for Innovation and Job creation and Social Dialogue;
- 2) Improve the image and attractiveness of the sector – to the young and society at large;
- 3) Actively pursue the development of new high-tech materials and innovative applications through up-skilling, R&D, creativity and design, knowledge and innovation transfer and promotion of entrepreneurship;
- 4) Actively address and implement the 10 actions foreseen in the Raw Materials Initiative;
- 5) Improve energy efficiency and environmental performance, also in transport;
- 6) Diversify personnel and take positive action;
- 7) Invest strongly in human capital.

Example. Strategic Options Decision Tool -- job function: <u>Managers</u>		
1. What is the maximum volume effect?	Maintain in both sub-sectors	
2. What is the maximum change in skills?	17	
3. Do SMEs play a large role?	Yes (glass+ceramics)/No (building materials)	
4. Is the sector national/EU/global?	Global (glass+ceramics)/EU (building materials)	
5. Is the workforce old?	Yes	
6. Is the workforce low educated?	No	
Option	Is this option viable?	Actors¹
A. Recruiting workers from other sectors	Yes, mainly for generic management skills	C, S, I
B. Recruiting workers from other Member States	Yes, when production sites have been offshored to/new productions sites have been established in these Member States	C, I
C. Recruiting workers from Non-Member States	Yes, when production sites have been offshored to/new productions sites have been established in these countries	C, I
D. Recruiting unemployed with or without re-training	No	-
E. Recruiting young people from the education system	Yes, mainly through apprenticeships, sector ambassadors in schools, use ‘sustainability’ image	C, S, E
F. Training and re-training employed workers	Yes, in-house promotion and further training in the firm	C, S, E

G. Changing work organisation	Yes, introduction new management concepts, self steering teams and flexible organisation concepts	C
H. Outsourcing and offshoring	Yes (glass and ceramics)/No (building materials)	C
I. Changing vocational education	New management concepts	S, E
J. Designing and offering new courses	Yes, emerging skills (such as)	S, E
K. Providing information about emerging skills	Yes	S, E, G
L. Improve the image of the sector	Yes, especially building materials image in recruiting young workers and diverse target groups (female, ethnic minorities)	C, S
M. Stronger cooperation between stakeholders	Partners in the value chain (glass and ceramics)/ partners in the supply chain (building materials)	C, S, E, I, U

Notes: 1. C (company), S (sector organisations and chambers of commerce), E (education & training), G (governments), I (intermediary organisation, public or private), U (Trade Unions).

Summary of changes in job volumes, skills changes, main strategic choices and main players in anticipatory action by scenario				
		Innovation-led growth	Conservation	Resource depletion
Managers	1. Employment volume change	+	0	0
	2. Skills changes counted	17	6	4
	3. Emerging skills needs	Entrepreneurship (trend setting & spotting), Management skills; Social skills, Problem solving skills, Knowledge	Knowledge (legislative, e-skills), Entrepreneurship, Problem-solving	Self-management, Knowledge (legislative & regulatory), Creativity
	4. Most important solutions	Recruiting, Training and retraining, Changing work organisation.	Training and retraining, Recruiting, Changing work organisation.,	Training and retraining, Recruiting, Changing work organisation, Improving image,
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
IT professionals	1. Employment volume change	+	0	-
	2. Skills changes counted	15	13	5
	3. Emerging skills needs	Knowledge (technical knowledge), Social skills, Management skills, Creativity,	Knowledge (technical knowledge), Social skills, creativity, Management skills, Trend setting/spotting,	Knowledge, Stress & time management, Management skills (project management, process)
	4. Most important solutions	Recruiting young and from other sectors, Training and retraining, Changing work organisation, Outsourcing,	Training and retraining, Recruiting young and from other sectors, Changing work organisation, Outsourcing,	Training and retraining, Recruiting young and from other sectors,
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
Other professionals	1. Employment volume change	+	+	0
	2. Skills changes counted	13	9	1
	3. Emerging skills needs	Knowledge (legislative & regulatory, technical, e-skills), Social skills	Knowledge (legislative & regulatory, e-skills), Social skills, Problem solving skills	Knowledge (e-skills)
	4. Most important solutions	Recruiting young and from other sectors, Training and retraining	Recruiting young and from other sectors, Training and retraining, Changing work organisation, Offshoring,	Recruiting young and from other sectors, Training, Providing information, Improving image, Stronger cooperation
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I
Engineers and R&D personnel	1. Employment volume change	+	+	-
	2. Skills changes counted	24	13	3
	3. Emerging skills needs	Knowledge (technical knowledge, legislative, e-skills), Social skills,	Knowledge (technical knowledge, legislative, e-skills), Management skills	Knowledge (technical knowledge) Flexibility, Stress & time management
	4. Most important solutions	Recruiting from other countries, Recruiting young, Training and retraining	Recruiting from other countries, Recruiting young, Training and retraining	Training and retraining, Changing work organisation, Improving image
	5. Most important actors	C, E, S, I, G	C, E, S, I, G	C, E, S, I
Accounting & Finance	1. Employment volume change	+	-	-
	2. Skills changes counted	11	10	3
	3. Emerging skills needs	Knowledge (legislative & regulatory , e-skills), Social skills, Management skills,	Knowledge (legislative & regulatory knowledge, e-skills), Management skills,	e-skills, flexibility, process management
	4. Most important solutions	Recruiting, Training and retraining, Outsourcing, Changing vocational education	Training and retraining, Recruiting, Outsourcing, Changing vocational education	Training and retraining, Changing vocational education, New courses
	5. Most important actors	C, E, S, I	C, E, S, I	C, E, S, I

C=Companies; S=Sectoral organisations, U=trade Unions; E=Education and training institutes; G=Government (EU, Member State, regional, local); I = Intermediary organizations.

		Innovation-led growth	Conservation	Resource depletion
Sales & Marketing	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	+ 21 Entrepreneurship (business development, marketing skills, trend setting / spotting) Recruiting young people, (Re)training, Outsourcing, New courses, C, E, S, I	0 12 Entrepreneurship (business development, marketing skills), Social skills, Recruiting young people, (Re)training, Outsourcing, New courses, C, E, S, I	0 5 Entrepreneurship (business development, marketing), e-skills, flexibility Recruiting young people, (Re)training, New courses, Providing information, C, E, S, I
Administrative support staff	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	0 11 Self management (all), Social skills, understanding suppliers & customers Recruiting young people, Training and retraining, Changing work organisation, C, E, I	- 9 Self management (all), Social skills, understanding suppliers & customers, Recruiting young people, Training and retraining, Changing work organisation, C, E, I	- 3 Self-management (planning, stress management, flexibility), team working, Recruiting young people, C, E, I
Truck drivers	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	+ 9 Knowledge, Self management, Social skills, Problem Solving Recruiting from other Member States, Outsourcing, Changing vocational education, C, E, S	- 9 Knowledge, Self management, Social skills, Problem Solving Recruiting from other Member States, Outsourcing, Changing vocational education, C, E, S	- 5 Self management, Social skills Recruiting from other Member States, Outsourcing C, E, S
Skilled production workers	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	+/- 14 Knowledge, Social skills, Self management, Problem solving skills, Quality management Recruiting young people, Training and retraining, Changing work organisation C, E, S, I	-/+ 11 Knowledge, Social skills, Self management, analytical skills, creativity Recruiting young people, Training and retraining, Changing work organisation, C, E, S, I	- 5 Knowledge, Self management Recruiting young people, Training and retraining, Changing vocational education, C, E, S, I
Plant and machinery repair and	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	0 18 Knowledge (legislative & regulatory, technical knowledge), Self management, Recruiting young people, Training and retraining, Outsourcing C, E, S, I	+ 12 Knowledge (legislative & regulatory, technical knowledge), Self management, Recruiting young people, Training and retraining, Outsourcing, C, E, S, I	- 5 Self Management (flexibility, stress management), Knowledge (e-skills, technical) Recruiting young people, Training and retraining, Outsourcing, C, E, S, I
Labourers	1. Employment volume change 2. Skills changes counted 3. Emerging skills needs 4. Most important solutions 5. Most important actors	- 11 Social skills, Knowledge, Self management, Problem solving skills, quality management Training and retraining, Changing work organisation, Outsourcing and offshoring, C, E, S, I	- 10 Social skills, Knowledge, Self management, multi-skilling, quality management Training and retraining, Changing work organisation, Outsourcing and offshoring, C, E, S, I	- 4 Social skills, Self management Training, up-skilling C, E, S, I