# FINAL REPORT

# THE SOCIO-ECONOMIC IMPACT OF THE NICKEL INDUSTRY IN THE EU:

# A BASELINE ANALYSIS

**Prepared for**

**European Nickel Group**

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## EXECUTIVE SUMMARY

### Introduction

The aim of the report is to present the findings of a study on the importance of the nickel industry to the economic prosperity of the EU.

The study uses a **"value chain"** approach to "map" the contribution of nickel to the EU. This examines the creation of wealth and jobs in an economy through the entire business process, from the production of basic raw materials through the successive manufacture of more sophisticated materials and components, to the purchase of finished products by consumers. This approach is particularly relevant for nickel because it is often used as an "enabling technology", due to its unique combination of properties. It provides manufacturers of nickel-containing alloys with access to a range of performance characteristics that create significant competitive benefits for their products. Moreover, the performance characteristics of the metal alloys, in turn, allow end-user, product manufacturers access to unique benefits.

The value chain for nickel involves three distinct tiers: the "Direct Nickel Industry", "First Use Sectors", and "End Use Applications".

- The **"Direct Nickel Industry"** comprises nickel mines, smelters and refineries. It includes the transport and logistical activities associated with the movement of nickel within the EU and the activities associated with the import of raw materials for refining (ore concentrates, nickel matte and nickel oxides) and refined nickel. The direct nickel industry also includes all activities associated with the recycling of nickel-containing products.

- However, only a small amount of nickel is used as a product in its own right. Most nickel is combined with other materials to produce nickel-containing alloys (such as stainless steel) with distinct performance characteristics. Nickel is also used as a plating material, and to produce special chemical products for batteries and catalysts. These are known as **"First Use"** applications.

  The nickel-containing alloys produced during the "First Use" stage are sold to product manufacturers both directly and indirectly. Those that are sold indirectly go via **"Intermediaries".** These include distributors who serve smaller customers (ensuring product availability and providing a "break-bulk" service) and fabricators, metal formers and surface engineering companies who undertake specialist services such as metal shaping, forming and sub-assembly.

- Product manufacturers use nickel-containing alloys as part of their manufacturing process. This group includes a number of manufacturers of components, sub-assemblies, and other products that are then used in the manufacture of further (finished) products. Collectively, they are known as **"End Use"** applications.

## Methodology

The aim of the study is to place a value (in terms of output and employment) on nickel’s distinctive contribution to the EU economy. However, nickel is an “enabling technology” not simply an industry sector. As such, it brings significant benefits to alloy manufacturers and to producers of many finished products.

Moreover, the relative value of nickel to product manufacturers differs between “End Uses”. In some instances, nickel is critical. In others, it is important, but alternative materials are readily available. The contribution of nickel to the EU economy differs in each of these cases.

Furthermore, nickel-containing materials are integrated with other materials and technologies along the value chain. In most situations, the relative contribution of nickel is, therefore, progressively diluted.

Hence, the nickel value chain is valued via two approaches:

- The first values nickel based on the concept of "critical dependency" to create the *narrow* value chain; *and*

- The second values nickel based on the *broad* value chain.

Specifically, the two value chains cover (See Exhibit 1):

- **"Direct Nickel Industry"**: Both value chains include primary ("new") nickel *and* nickel from recycled sources.

- **"First Use"**: Only a small amount of nickel is used as a substance in its own right. In most situations, it is combined with other substances to produce nickel-containing alloys such as stainless steel:

    - In the narrow value chain, all "First Use" applications of nickel are included in the analysis because nickel creates *significant relative competitive benefit* for the alloy producer.

    - In the "First Use" tier of the broad nickel value chain, ferritic stainless steel and non-nickel plating are included. This is because austenitic (nickel-containing) stainless steel accounts for 70% of the sales of stainless steel and nickel-plating accounts for 40% of gross margin for many plating businesses. This means that many businesses would be uneconomic and close without nickel-containing alloys.

- **"End Use"**: Nickel-containing alloys are used in a wide range of products.

    - Thirteen "End Uses" that are *critically dependent* on nickel constitute the narrow nickel value chain.

    - The broad "End Use" value chain includes *all* "End Uses".

**Exhibit 1: Narrow and Broad Nickel Value Chains**
Source: THE WEINBERG GROUP

The report concentrates, for the most part, on the narrow value chain - the critically dependent elements of the value chain:

- For each tier of the narrow value chain, a range of indicators is developed: value-added, employment, salaries and wages, capital expenditure, R&D, capital employed, and taxes.

- The broad value chain concentrates on value-added and employment.

Independent third-party data sources were used, wherever possible, to provide estimates of key indicators such as volume and sales value (turnover). These were complemented by industry expert assessments, unpublished company studies, data provided directly by companies, and study estimates. Estimates were subsequently validated using specialist consultants, company experts and industry experts. The process followed was an iterative one.

## Key Findings

The EU is a major user of nickel. Total European use in 2002 was more than 700kt, which represented around 40% of global demand. The EU market is currently growing at 3-5% per annum. This means that the intensity of nickel use in the EU is also increasing, as nickel use is expanding faster than GDP.

The supply of nickel is an international business and European use is satisfied through a combination of EU mining of nickel ore, EU production of refined nickel, imports of refined nickel, and recycling of existing nickel from the EU and third countries.

Whilst the EU nickel industry itself is relatively small, it has a significant impact on the EU economy through its value chain. Moreover, through its critical use in nickel-containing alloys, it has a major impact on leading EU industries.

- The EU is the world's largest producer of stainless steel and EU companies are the market leaders. Leadership in "First Use" industries has also led to the development of "cluster benefits" for the EU; supplier industries, such as the plant building industry, have themselves become global leaders, and a highly developed "innovation system" now exists.

- A number of important "End Use" sectors in Europe are *critically dependent* on nickel. These include the manufacture of jet engines, the production of process plant equipment used in important industries such as food and drink, oil, chemicals and pharmaceutical production, and the pressing of CDs and DVDs.

Hence, the total value-added by the nickel industry and its narrow value chain - critically dependent uses - is estimated to be Euro 40 billion.

For the broad nickel value chain, the total value-added is estimated to be of the order of Euro 80-100 billion.

The "Direct Nickel Industry" and the industries in its value chain that are *critically dependent* upon it, employ a substantial number of people. It is estimated that 475,000 people are employed in the EU by the nickel industry and its narrow value chain - "First Use" industries and "End Use" product manufacturers who are critically dependent on nickel.  This represents 2% of total manufacturing employment in the EU.

Moreover, the nickel industry and its value chain create additional employment in the economy through capital expenditure and "multiplier" effects, as each euro of expenditure on goods and services by companies in the nickel industry and its value chain generates additional employment in other sectors, especially services. Taking account of these effects, it is estimated that 700,000 jobs in the EU are *critically dependent* on nickel.

In the nickel industry and its broad nickel value chain, it is estimated that 0.75-1.00 million people are employed in the nickel value chain (3-4% of total manufacturing employment in the EU.  Taking account of the multiplier effects, it is estimated that 1.25-1.5 million jobs in the EU may be dependent on nickel.

Many of these jobs are high skill manufacturing jobs, particularly those in nickel refineries, stainless steel plants and “End Use” sectors such as jet engine manufacturing. Other sectors, such as metal fabricators employ a larger proportion of lower skilled people.

Salaries and wages paid by the nickel industry and its narrow value chain to these employees amount to an estimated Euro 20 billion.

The industry and its narrow value chain also contribute significantly to Europe’s economy through high levels of investment:

- Investment in R&D is estimated to be Euro 2 billion per annum, equivalent to 2% of annual R&D expenditure by business in the EU.

- Capital expenditure amounts to an estimated Euro 2.6 billion per annum, equivalent to 1.5% of annual manufacturing investment in the EU.

The nickel industry and its narrow value chain also account for substantial tax revenues:

- Employees and employers pay Euro 10 billion in employment taxes (income taxes and social charges);

- Companies pay an additional net Euro 4 billion in sales taxes; and

- Companies also pay corporation tax and other local taxes.

# 1. INTRODUCTION

## 1.1. Nickel

Nickel is the fifth most common element in the earth. Nickel is usually found in the earth's crust in the form of complex nickel oxides. It is also found in the molten core of the earth and major geological disturbances, like volcanic eruptions, can bring this molten material near to the surface, usually as complex sulphides.

Commercial nickel mining today is based on these two kinds of natural occurrences: oxide and sulphide:

Oxide ore mines operate in countries such as New Caledonia, Greece, Indonesia, Philippines, Columbia, The Dominican Republic, Australia, and Cuba. Potentially valuable oxide ores exist in many other countries, but have not yet been developed.

Sulphide ore mines are based in Russia (Siberia), Canada, Australia, Southern Africa, China, and Brazil. New developments are also taking place in Western Europe, such as the new Portuguese sulphide ore project.

In addition to the abundant ore reserves, there is a strong commercial incentive for recycling because nickel is an expensive material. Most nickel products have a lengthy life cycle that averages more than 25 years. At the end of the life of these products, nickel can be recycled repeatedly.

Nickel is rarely used in its purest form. Most nickel is combined with other metals to form alloys. As a transition metal, it combines readily with other metals, especially iron, chromium and copper, to produce alloys with particular combinations of properties that cannot be achieved by pure metals:

- Alloys of iron, nickel and chromium can be formulated to combine strength and ductility with resistance to corrosion in various environments. The most widely known of these alloys is stainless steel, which is increasingly used in transportation, construction and in industrial applications in the chemical industry and in oil and gas engineering, where the environment can be very corrosive.

- Other alloys of nickel, chromium and other metals have been developed for very high temperature strength and corrosion resistance. These alloys are used in jet engines and in industrial gas turbines for electricity generation. They are also used in heater elements, resistance wires, heat exchangers in power plants, furnace components, and in industrial pumps and valves.

- Other nickel-containing alloys are used for specialist applications requiring special properties like magnetic attraction and controlled expansion. Alloys of nickel and iron are used in television sets and other electronic applications, whilst nickel-containing alloy steels are used in the automotive industry and in other special applications.

- Alloys of copper and nickel are widely used in marine engineering applications and in coinage. Nickel is also a key component of high performance rechargeable battery systems and catalyst systems.

- Thin coatings of nickel are used to protect materials that would otherwise corrode and fail. Nickel coating, otherwise known as nickel plating, is often used together with chromium (nickel-chromium plating) to produce high durability. This is used to produce bright shiny wheels, door handles and other decorative fittings for cars. Nickel-chromium plating is also used to produce other consumer items such as bathroom fittings, shop fittings and furniture. The combination of a layer of nickel followed by a very thin layer of chromium confers quality appearance and excellent wear resistance to steel, brass and plastic substrates.

Nickel products, therefore, play important enabling roles in many technologies to provide corrosion resistance, strength at high temperatures, easy fabricability and other special properties, and additional economic value in the form of higher productivity, longer life and better quality.

## 1.2. Value chains

"**Value chains"** examine the creation of wealth and jobs in an economy through the entire business process, from the production of basic raw materials through the successive manufacture of more sophisticated materials and components, to the use of finished products by consumers.

This approach is particularly relevant for nickel because it is often used as an "enabling technology", due to its unique combination of properties. It provides manufacturers of nickel-containing alloys with access to a range of performance characteristics that create significant competitive benefits for their products. Moreover, the performance characteristics of these metal alloys, in turn, allow product manufacturers access to unique benefits.

## 1.3. The Nickel Value Chain

The value chain for nickel, however, is complex. It involves three distinct tiers. These are the "Direct Nickel Industry", "First Use Sectors", and "End Use Applications". This is described in Exhibit 2.

**Exhibit 2: The Nickel Value Chain**
Source: THE WEINBERG GROUP

- The **"Direct Nickel Industry"** comprises nickel mines, smelters and refineries. It also includes the transport and logistical activities associated with the movement of nickel within the EU and the activities associated with the importation of raw materials for refining (ore concentrates, nickel matte and nickel oxides) and refined nickel. The "Direct Nickel Industry" also includes all activities associated with the recycling of nickel-containing products.

- However, only a small amount of nickel is used as a product in its own right. It is usually combined with other materials to produce nickel-containing alloys (such as stainless steel) with distinct performance characteristics. Nickel is also used as a plating material, and to produce special chemical products for batteries and catalysts. These are known as **"First Use"** applications.

  The nickel-containing alloys produced during the "First Use" stage are sold to product manufacturers both directly and indirectly. Those that are sold indirectly go via **"Intermediaries".** These include distributors who serve smaller customers (ensuring product availability and providing a "break-bulk" service) and fabricators, metal formers and surface engineering companies who undertake specialist services such as metal shaping, forming and sub-assembly.

- Product manufacturers use the nickel-containing alloys as part of their manufacturing process. This group includes a number of manufacturers of components, sub-assemblies, and other products that are then used in the manufacture of further products. Collectively, they are known as **"End Use"** applications.

## 2. OBJECTIVES AND SCOPE

In March 2003, the Nickel Development Institute (NiDI) commissioned THE WEINBERG GROUP to conduct an independent study of the socio-economic impact of the nickel industry on the European Union.

The aim of the study is to gain a better understanding of the importance of the nickel industry to the economic prosperity of the EU - a "mapping" exercise, designed to establish a "baseline" showing the contribution of nickel to the EU.

The purpose of this report is to present the findings from this study.

In **Section 3**, the methodology is described.

In **Section 4**, the key findings from the study are summarised. In particular, key indicators of socio-economic impact[1] are reported:

- Value-added;
- Employment;
- Salaries and Wages;
- R&D;
- Capital Expenditure;
- Taxes; *and*
- Capital Employed.

These indicators were chosen because they represent some of the most important ways of measuring the socio-economic contribution of nickel. Moreover, they are also quantifiable and widely understood.

In **Section 5**, key conclusions are drawn.

The **Annexes** to the report include a glossary of terms, a bibliography, and the key data from the analysis.

[1] The study does not attempt to quantify other social, health and environmental benefits from nickel to the EU and the rest of the world, particularly developing countries. Some wider social benefits are explored qualitatively in the THE WEINBERG GROUP report "Valuable Use Scenarios". Moreover, the study is an analysis of the positive contribution of nickel to the EU. It does not attempt to analyse what might happen if nickel ceased to exist

# 3. METHODOLOGY

This section explains the methodology used in the study. It deals, in particular, with the methodological challenges faced and the solutions. It also defines key concepts and terms. It then describes the overall process used to carry out the study and explains how the key concepts are applied at each stage of the value chain.

## 3.1. Overall Approach

The overall objective is to gain a detailed understanding of the importance of the nickel industry to the economic prosperity of the EU. Our principal aim, therefore, is to place a value on nickel's distinctive contribution to the EU economy.

However, nickel is an "enabling technology", not simply an industry sector or group of related sectors. As such, it brings significant benefits to alloy ("First Use") manufacturers and to "End Use" producers of finished products.

Moreover, the relative value of nickel to product manufacturers differs between "End Uses". In some instances, nickel is critical. In others, it is important, but alternative materials are available, although with less-preferred functionality and/or economics. Hence, the contribution of nickel differs in each of these cases.

Furthermore, as nickel moves along the value chain, it is integrated with other materials and technologies. In most situations, the relative contribution of nickel is progressively diluted, until it is no longer material to the finished product. An additional challenge is, therefore, to decide where to "cut-off" the valuation in the value chain.

To overcome these challenges, the nickel value chain was valued in two approaches:

- The first valued on the basis of "critical dependency"[2] to create the *narrow* value chain
- The second valued nickel on the basis of the *broad* value chain that included less critical end-uses.

Exhibit 3 contains two examples that explain the two value chains.

[2] Other studies have also used this approach. See, for example, a recent report by the Surface Engineering Association for the Department of Trade and Industry in the UK: "The UK Surface Engineering Industry to 2010" NASURF (1998)

**Exhibit 3: Nickel Dependency**
Source: THE WEINBERG GROUP

## 3.2. Key Definitions and Concepts

### *3.2.1. Value-added*

Value-added is a measure of the contribution of nickel to the economic output (wealth) of the European Union. As such, it includes companies that provide key inputs (products and services) to nickel-using companies.

Value-added is estimated at each stage of the value chain by taking the value of production in the EU (for domestic and export markets) and deducting the value of inputs from the previous stage in the value chain and the value of imports from outside the EU.

### *3.2.2. Employment*

Employment refers to jobs that are "dependent" on nickel. At all times it is expressed in terms of "Full-Time Equivalents" (FTEs). Total employment estimates consist of three elements:

- **Direct employment.** This is the number of employees on employment contracts *plus* the number of individuals carrying out tasks that were traditionally carried out in-house (e.g. logistics) but are now carried out on a sub-contracted basis ("out-sourced").

  Estimates of direct employment were calculated using a mix of sources. For the nickel industry itself, data on employment in mining and refining activities was obtained from companies and published information. Other estimates were made using relevant sales per employee ratios, which were derived in the main from relevant company accounts, and relevant ratios of sub-contracted employment.

- **Multiplier effect**. This is the number of individuals employed in other sectors, especially services as a result of expenditure on goods and services by employees and companies in other industries.

  There are two principal types of multiplier – income multipliers and supplier multipliers. Income multiplier effects occur as people employed in companies spend their income, often in the local area. This, in turn, creates jobs, particularly in service sectors such as retailing and in-home services. Supplier multiplier effects occur as businesses buy in goods and services from other companies.

  Research suggests that for a mix of low, medium and high tech businesses, an average combined income and supplier multiplier of between 1.3 and 1.5 is appropriate to estimate indirect employment effects[3]. In other words, for each direct job, between 0.3 and 0.5 additional jobs exist elsewhere in the economy. For medium to high-tech sectors, the ratio is likely to be higher. Indeed for high-tech sectors, research suggests that a ratio of 2.0 to 2.5 may be appropriate. However, in the interests of prudence, this study was based on a multiplier of 1.4 – in other words, for each direct job, 0.4 indirect jobs exist elsewhere in the economy.

- **Capital Expenditure Effect**: Many of the industries in the nickel value chain are capital-intensive. An additional estimate has been included to capture the employment associated with investment in new or refurbished process plant. This was calculated on the basis of a standard ratio of jobs to capital expenditure. This study assumes that one job is created for every Euro 120,000 invested[4].

### *3.2.3. Salaries and Wages*

This refers to the salaries and wages paid to people whose jobs are "dependent" on nickel. Estimates include the jobs associated with the "Direct Employment", "Multiplier" and "Capital Expenditure" categories.

[3] See, for example, Centre for Strategy and Evaluation Services "Multipliers and High Tech Businesses" (2002)
[4] Centre for Strategy and Evaluation Services "Multipliers and High Tech Businesses" (2002)

Salaries and wages are calculated by multiplying the number of jobs by average gross wages per person. These are derived from a combination of sources including OECD data on the gross pay for the "Average Production Worker"[5] and estimates of gross wages in selected sectors based on company accounts and information from experts.

### *3.2.4. Sales*

This refers to the value of production in the EU, both for domestic consumption and for export. It is calculated, in the main, by multiplying volumes produced by average selling prices, derived from OECD sector averages, company accounts and information from experts[6].

### *3.2.5. Capital Expenditure*

Capital expenditure refers to the value of fixed assets (such as land, buildings, transport equipment, machinery and other equipment) purchased.

Estimates of capital expenditure are based on investment as a percentage of sales derived from OECD sector averages[7].

### *3.2.6. Capital Employed*

Capital employed is a measure of the financial resources dedicated to supporting business activity. It comprises equity and debt capital used to fund fixed assets (as defined above) and net current assets (including trade debtors and stocks less trade creditors).

Estimates are derived using standard business ratios:

- For Direct Industry and "First Use", total capital employed is based on a ratio of capital employed to sales, which varies by specific sector. This is derived from industry estimates and company accounts.

- For "End Use" sectors, fixed assets are estimated using a standard ratio of 10 times annual capital expenditure, and net current assets using as ratio of one third of total assets. These ratios are derived from a review of company accounts in relevant sectors.

### *3.2.7. Research and Development*

This refers to expenditure by companies on research and development (R&D).

Estimates are based on data from the OECD on total business enterprise expenditure on R&D[8], and on R&D as a percentage of Sales for individual sectors[9].

[5] OECD "Structural Statistics for Industry and Services" (2003)
[6] OECD "Structural Statistics for Industry and Services" (2003)
[7] OECD "Structural Statistics for Industry and Services" (2003)
[8] OECD "Main Science and Technology Indicators" (2002)

### *3.2.8. Taxes*

Two types of taxes are included in the analysis:

- **Employment taxes.** These include taxes paid by both the employee (income tax and social charges) and by the employer (social charges).

  Employee taxes are calculated using average tax rates for the EU for a married person with two children. Employer social charges are based on OECD data[10]

- **Sales taxes** paid by companies. These are calculated net of input value-added taxes recovered by companies.

  The basis of the estimate is value added per sector as a percentage of sales. For "End Use" sectors, estimates are based on OECD data[11]. For the Direct Industry and "First Use Sectors", estimates are based on expert industry estimates. An average Sales Tax rate across the EU of 20% was assumed.

Estimates of the taxes paid by the nickel industry and its value chain *exclude* corporate taxes and local taxes paid by companies.

## 3.3. Data Sources

Data from independent third-party sources is the basis of the key indicators, such as volumes and sales values is. Where necessary, this is complemented by industry expert assessments, company accounts, unpublished company studies, data provided directly by companies, and study estimates.

A full list of sources is included in the bibliography in Annex B and individual sources are also referenced to the data in the notes to each table contained in Annex C. Examples include:

- **General sources.** These include OECD and EUROSTAT.

- **Nickel and Stainless Steel specific sources**. These include INSG "World Nickel Statistics", Brook Hunt, CRU International, and Heinz Pariser "World Stainless Steel Statistics".

- **Company accounts, reports and press releases:** These include nickel industry companies, stainless steel companies, and "End Use" companies.

- **Unpublished studies.** These include NiDI "Nickel Flows".

[9] OECD "Science and Technology Scoreboard" (1999)
[10] OECD "OECD in Figures" (2002) and OECD "Structural Statistics for Industry and Services" (2003)
[11] OECD "Structural Statistics for Industry and Services" (2003)

Estimates have been validated using specialist consultants, company experts and industry experts. These are also listed in Annex B.

## 3.4. The Process

The process used in this study is an iterative one. This is illustrated in Exhibit 4.

**Exhibit 4: The Nickel Value Chain: The Process**
Source: THE WEINBERG GROUP

1. **Draft Model.** In the first stage of the study, in-depth discussions were conducted with representatives of the nickel industry to obtain an overall view of the nickel value chain. Desk research was also undertaken to identify relevant sources of published data. This part of the process culminated in the production of a first draft model of the nickel value chain.

2. **Revised Model.** The sources of data identified in the desk research, further unpublished studies, data identified during discussions with the nickel industry and interviews with experts were used to produce a revised model, containing provisional estimates for key indicators such as value-added and employment.

3. **Draft Output.** These initial estimates were then subject to extensive further research using published data, unpublished studies and further data provided by companies in the "Direct Industry" and "First Use" industries. A number of site visits were made and further in-depth interviews were conducted[12]. Databases were searched to identify key companies in specific sectors and relevant additional data such as turnover and the number of employees. As the estimates were progressively refined, they were subjected to expert review, using consultants and other experts working in specific industries. This part of the process culminated in the production of a first estimate of the nickel value chain.

4. **Revised Output.** This was then subject to further checking and validation by representatives of the nickel industry, "First Use" industries, and relevant experts working in "End Use" industry sectors. Revisions were made to the model to take account of comments received. This process ended with the production of a revised (agreed) nickel value chain.

## 3.5. Applying the Methodology: The "Direct Industry"

The analysis of the "Direct Nickel Industry" covers both primary ("new") nickel *and* nickel from recycled sources in the entire value chain, because most "First Use" sectors derive nickel from all sources.

Included are both indigenous EU nickel production (mining and smelting/refining) and the EU-based activities associated with the import of raw materials (ore concentrate, and nickel matte and nickel oxides) and refined nickel. The transport and logistical activity associated with the movement of nickel within the EU is also included.

[12] Fifteen site visits and in-depth interviews were conducted and twenty five telephone interviews were carried out

Recycling is an important activity in the EU and includes collectors/dismantlers of scrap, middlemen, importers of scrap and scrap processors. Recycled nickel is also derived from fabricator and service centre scrap and mill home scrap. The estimates for nickel recycling take account of all the recycling of nickel-containing alloys and products that takes place in the EU. Most of this takes the form of recycling old nickel-containing alloys into new nickel-containing alloys, rather than back into nickel. But because the value of the nickel is the dominant economic driver for this, all nickel-related recycling has, for the purposes of this study, been considered as "nickel recycling"[13]

### 3.6. Applying the Methodology: "First Use"

Only a small quantity of nickel is used as a substance in its own right. In most situations, it is combined with other substances to produce nickel-containing alloys such as stainless steel. The use of nickel confers distinctive properties on the alloy produced.

In the narrow value chain, all "First Use" applications have been included because nickel creates *significant relative competitive advantages* for alloy producers. Specifically manufacturers of nickel-containing alloys use nickel either because:

- It is an "enabling technology" and they cannot produce specific beneficial performance characteristics without it (such as corrosion resistance, formability and weldability); *or*

- Alternative materials would lead to substantial deterioration in the performance of their alloys or in the productive efficiency of their plants.

Moreover, nickel is a very high cost input (around Euro 6,500 per tonne in 2002[14]) and would not be used if alternative lower cost inputs could be found that produced similar benefits.

The narrow nickel value chain, therefore, covers the main "First Use" applications of nickel, including stainless steel, alloy steels, non-ferrous alloys, foundry and plating[15].

It also includes an analysis of "Intermediaries", particularly distributors, fabricators, metal formers and surface engineering companies.

The broad nickel value chain includes:

- **Ferritic stainless steel.** This does not contain nickel and was therefore excluded from the narrow value chain. However, the economics of stainless

[13] There is no published source of data on the scale of nickel recycling in the EU. A NiDI study of "Nickel Flows" (2001) has, therefore, been used as the basis for our estimates of recycling. This is based on scrap flows in 2000 and concluded that the split of new nickel to recycled nickel was 60/40. It is unlikely that these proportions have changed significantly since 2000
[14] In comparison, the 2002 price of copper, aluminum and mild steel was much lower at Euro 1,460/te, Euro 1,260/te and Euro 210/te respectively
[15] This study excludes consideration of the socio-economic impact of "Other Uses" (such as batteries, chemicals and catalysts). It therefore understates the total value of the nickel industry

steel plants are driven by austenitic (nickel-containing) stainless steel as this represents 70% of volume, so many stainless steel businesses might be uneconomic without austenitic (nickel-containing) stainless steel.

- **Non-nickel Plating**. Around 70% of plating activity does not contain nickel, so it was excluded from the narrow value chain analysis. However, nickel-plating accounts for more than 40% of the gross margin, so many plating businesses might be uneconomic and close without nickel plating.

## 3.7. Applying the Methodology: "End Use"

Nickel-containing alloys are used in a wide range of products – some of which are critically dependent on nickel; others less so.

### *3.7.1. The Narrow Value Chain – "End Uses", which are critically dependent on nickel*

The narrow value chain is confined to those "End Uses" that are *critically dependent on nickel*, where:

- The nickel-containing alloy significantly transforms either the production process or the end product; *and*

- The transformation could not be achieved any other way without a substantial reduction in the performance of the product, a major deterioration in the production process, or a substantial increase in the price.

Thirteen "End Use" applications meet these criteria and are, therefore, included in the narrow vale chain "End Use" analysis[16]. "End Use" markets that do not meet the criteria are not included.

*Automotive Diesel Turbo-chargers*

Automotive diesel turbo-chargers are miniature turbines, which are driven by the hot exhaust gases collected by the exhaust manifold. The turbine in turn drives a small compressor, which delivers compressed air to the main engine, resulting in the production of more energy at the point of ignition. The turbo-charger, therefore, produces more power and greater fuel efficiency than a naturally aspirated engine of similar capacity. In Europe it is now standard practice for all diesel-engine cars to be fitted with turbochargers.

Nickel-chromium alloys are essential to the performance of turbochargers as they are the only metal that provides the combination of properties (creep resistance combined with fracture-toughness) that meets the performance criteria for the turbines.

[16] For further information about these critical applications, please refer to THE WEINBERG GROUP report "Valuable Use Scenarios" and to http://www.nickelmagazine.org

Hence the value of diesel turbo chargers produced in the EU has been included in the narrow value chain.

*Aerospace: Jet Engines*

Aerospace "jet" engines are gas-turbine engines that have largely replaced internal combustion engines for aeronautical use, initially in military applications and later in civil aviation. The change has brought about a transformation in the performance of military fighter aircraft and in the range and passenger-carrying capacity of airliners. This improvement was due primarily to the outstanding power-to-weight ratios of gas-turbine engines.

Nickel-containing super alloys are essential to the successful operation of these engines. Both the performance and fuel-efficiency of the engine require the critical components (blades, nozzles and discs) to operate at very high stresses, rotational speeds and temperatures. Only nickel-containing "superalloys" provide the combination of properties (creep resistance combined with fracture-toughness) that meets these criteria.

Hence the value of jet engines produced in the EU has been included in the narrow value chain.

*Industrial and Marine Gas Turbines*

The use of gas turbine engines for industrial power generation has become widespread since the 1970s and continues to grow rapidly. In part, this growth has reflected the increasing availability and reducing cost of natural gas in many parts of the world but it can also be attributed to the distinct advantages of gas turbines over traditional forms of generation in terms of flexibility, efficiency and environmental protection. Similar issues have influenced the growth in the use of gas turbines for heavy marine applications where they have frequently replaced heavier, less efficient diesel engines.

As nickel alloys are essential to the successful operation of aerospace gas turbines, they are equally essential for their land and water-based equivalents. Much of the technology developed for aero engines has been successfully transferred to power generation and marine transport.

Hence the value of industrial and marine gas turbines produced in the EU has been included in the narrow value chain.

*Process Plant in the Food and Drink Industry*

In developed economies, the food processing chain is highly complex, and many foods are processed and packaged via a multi-stage route that may include low temperature storage, sterilization, bulk transportation, the manufacture of “prepared” foods, and packaging. It is essential that all of the equipment used in these processes (such as pumps, valves, vessels, heat exchangers and tubing) is reliable, easily maintained and cleaned, and resistant to sanitising chemicals. Moreover, it must not contaminate or taint food.

Nickel-containing austenitic stainless steels have become the materials of choice for nearly all sectors of the food-processing industry, as they have the ease of fabrication necessary to build sophisticated handling equipment and the hygienic properties needed to fulfil all of the above criteria. Other materials such as glass, aluminium, enamelled steel, plastics and ceramics are still used for very specific applications and components but none of them provide the unique combination of properties that makes austenitic stainless steel preferable for most types of process plant in the food and drink industry.

Hence the value of stainless steel-based food processing equipment produced in the EU has been included in the narrow value chain.

*Process Plant in the Oil and Gas Production Industry*

Oil and gas production equipment often has to operate in aggressive conditions either because of the surrounding environment or because of the nature of the product involved. The product is usually hot and under pressure, and may contain corrosive chemicals; the equipment may be offshore - either on a platform or under the sea.

Reliability is essential because equipment failure may mean injury, loss of production, expensive repairs or environmental damage.

In benign conditions, carbon steels may be used. However, when corrosive conditions are more severe (e.g. due to high concentrations of $CO_2$ and/or $H_2S$) corrosion-resisting alloys are essential to ensure reliability and safety. The material chosen for these applications is typically a duplex stainless steel, a super austenitic stainless steel or a nickel-containing alloy. In all three cases, the presence of nickel as an alloying element is essential to achieve the necessary corrosion performance, strength and ease of fabrication.

Hence the value of nickel-containing process plant used for oil and gas production manufactured in the EU has been included in the narrow value chain.

*Process Plant in the Petroleum Refining Industry*

Petroleum refining involves purifying and separating the complex mixture of hydrocarbons in crude oil into its usable fractions, such as gasoline, diesel and fuel oil. At the same time, the proportion of those fractions can be altered by chemical treatment to meet changing demand. Many of these processes have to be operated at high pressure and high temperature in order to be economic and minimise energy use.

Reliability of the plant is paramount in order to maintain production and to ensure safety - the chemicals being processed are often extremely flammable and toxic. Hence leakage could result in major loss of life and damage to the plant and environment. It is therefore essential that materials used to construct the plant are able to withstand the high temperatures and pressures over a long service life. Only nickel-containing alloys satisfy the exacting criteria demanded by plants of this type.

Hence the value of nickel-containing process plant used for petroleum refining in the EU has been included in the narrow value chain.

*Process Plant in the Chemicals Industry*

Most chemicals are produced by synthesis from relatively simple chemical building blocks. However, many production processes involve reaction vessels and heat exchangers that need to operate at high temperatures or at high pressure or contain aggressive chemicals. Some of the reactants may be highly flammable, toxic or harmful to the environment if released.

Reliability of the plant is paramount to maintain production and to prevent leakages which could cause major health or environmental problems. The plant may also need to be corrosion resistant at ambient temperatures or high temperatures; it may need to withstand oxidation and other forms of high temperature degradation; it may need mechanical strength at both ambient and high temperatures. The plant must also be easy to built, economic and have a long service life. In the majority of cases, the alloy, which provides the optimum combination of properties for process plant, will be either a nickel-containing stainless steel or a nickel-base alloy.

Hence the value of nickel-containing process plant for chemical production manufactured in the EU has been included in the narrow value chain.

*Process Plant in the Pharmaceuticals Industry*

Most pharmaceuticals are produced under factory-controlled conditions. However, such a high degree of mechanisation increased the risk of contamination unless the equipment used, and the conditions surrounding it, are scrupulously clean. As in the preparation of food products, the material most used in the pharmaceutical industry is nickel-containing austenitic stainless steel because of ease of fabrication, polishing, cleaning and sterilisation and because of resistance to tarnishing.
Only nickel-bearing austenitic stainless steels provide this unique combination of properties so essential to the safe preparation and handling of pharmaceuticals.

Hence the value of stainless steel-based process plant manufactured in the EU for use in the pharmaceutical industry has been included in the narrow value chain.

*Commercial Catering Equipment*

The public health implications of unhygienic commercial catering establishments are severe. Good hygienic practice is, therefore, enforced with increasing vigour and this has had a strong influence on the materials chosen for handling, cutting, mixing and cooking basic ingredients and prepared foods.

The toughness, ease of cleaning and heat-resistance of nickel-bearing austenitic stainless steels has enabled chefs to satisfy their need for ovens and cooking utensils that will not contaminate or taint food, regardless of how often they are cleaned. The ease of fabrication and weldability of these steels enables such basic equipment as water heaters, sinks, worktops, cooker hobs and shelves to be designed without sharp crevices, grouted joints or other surface imperfections that can harbour bacteria. At the same time, their hardness and heat-resistance enable them to withstand the high levels of wear and tear that are characteristic of nearly all commercial catering establishments. The extensive use of austenitic stainless steels enables modern kitchens to meet the exacting standards set by government health agencies which consumers have come to expect.

Hence the value of stainless steel-based commercial catering equipment produced in the EU has been included in the narrow value chain.

*Beer Kegs*

Traditionally “draught” beer was dispensed from wooden barrels, but these suffered from two major disadvantages:

- Firstly, the skills of craftsmen (coopers) were required to maintain the supply of new barrels and to repair those that were damaged as a result of heavy handling.

- Secondly, wood provides a surface to which micro-organisms can readily attach and grow. It was therefore, difficult to avoid bacterial contamination of the beer and the industry had to accept a very short shelf life for its products.

Most draught beer consumed in Europe nowadays is artificially filtered and sterilised after fermentation to ensure a uniform taste and perfect clarity. To preserve this quality, the containers (kegs) must be perfectly clean and sterile at the time they are filled and must be capable of withstanding the internal pressure produced by artificial carbonation. Wooden containers are not able to meet these criteria.

Although aluminium beer kegs were used for a number of years, these are no longer manufactured in Europe and are being quickly phased out. This has left austenitic (nickel-containing) stainless steel as the only material that meets the demands of the modern brewing industry. Its hygienic properties make the kegs easy to clean, while its corrosion resistance enables strong sterilising agents (such as caustic alkalis and acid baths) to be used to clean them. Durability is another significant advantage – a properly maintained stainless steel keg has a lifespan of 30 years or more and can withstand the hard knocks it will encounter between the lorry and the cellar. Stainless steel kegs may also be periodically reconditioned to meet changing specifications for capacity and cleanliness.

Hence the value of stainless steel-based beer kegs produced in the EU has been included in the narrow value chain.

*Medical and Dental Instruments and Hospital Equipment*

Medical and dental instruments must be highly functional and easy to sterilise in order to minimise the risk of infection during use. It must be easy to remove soil and bacteria from them, and they must resist both heat and corrosive sterilising chemicals. Similar considerations apply to much hospital equipment such as cabinets, trolleys and the sterilisation vessels themselves.

To ensure ease of cleaning in service, such articles must have smooth-flowing designs that avoid corrosion and crevices, which may form traps for soil and bacteria. In addition, a high polish makes it more difficult for soil and bacteria to adhere and facilitates easy removal. Another essential requirement is that the materials from which they are made are “safe” for surgical contact – in other words they do not release harmful or toxic impurities into the body fluids that they may encounter.

Nickel-containing stainless steels fulfil all of these requirements in that they are easily fabricated into the optimum design because of their ductility and ease of welding. They may also be polished to a smooth finish that is sufficiently wear-resistant to avoid significant surface damage. Also, their corrosion resistance is such that they do not tarnish with age. Moreover, the strength and ductility of the nickel-containing stainless steels means that articles will be robust in use and their heat and corrosion resistance mean that they will be unaffected by either thermal or chemical sterilisation. Therefore safe re-use of instruments and equipment is possible. Indeed, a testimony to the "health" credentials of austenitic stainless steels is that they are regularly used in dentistry and prosthetic surgery.

Hence the value of stainless steel based medical and dental instruments and hospital equipment produced in the EU has been included in the narrow value chain.

*High Precision Replication: CD and DVD Pressing*

Information on mass-produced CDs and DVDs is stored as minute pits that are detected by the reflection of laser light when the disc is read. The fidelity of the reproduction of the information (data) primarily depends on the accuracy of the pits. In turn, that depends on how faithfully the moulds that are used to stamp the discs reproduce the original master - and continue to do so through a long production run.

Electroformed nickel faithfully reproduces the very fine detail of the surface of the master on which it is deposited. It can be built up quickly into a sufficiently thick layer so that it can be removed from the master without damage and remain flat. Unlike other electroforms, nickel electroplating has the durability to withstand the moulding of large numbers of discs, each of which will give the high fidelity reproduction demanded by consumers. The process was first used in the 1930s for 78rpm records, then for 33rpm long-playing vinyl records, and is still the basis of CD and DVD manufacture today.

Hence the value of CD and DVD pressing activity produced in the EU has been included in the narrow value chain.

*High Precision Replication: Electroformed Screen Printing*

The coloured designs on carpets, textiles, wallpaper and many packaging products are frequently applied by continuous rotary screen printing. The origins of the process go back over 1000 years but today a stencil is formed in lacquer on a cylindrical mesh screen by "photo-resist" or laser etching techniques. The ink is then forced from the inside of the rotating screen, through the open areas of the design, onto the material to be printed in the printing press. One screen is required for each colour to be printed. For carpets, the screen may be up to six metres wide.

The screen must have a very fine, uniform mesh. It must have sufficient strength to withstand the printing force, not be attacked by the inks, be easily cleaned and have a long life. Screens are made from electroformed nickel because its accuracy, strength, and corrosion resistance allows the production of seamless screens that meet these requirements. They are sufficiently robust to be used not only for repeat runs but also re-used for new patterns.

Hence the value of electroformed screens produced in the EU has been included in the narrow value chain.

### *3.7.2. The Broad Value Chain – "End Uses" that are less critically dependent on nickel*

There are a large number of applications in the "End Use" sector, which are less critically dependent on nickel. This is not because the nickel does not play an important role, but because alternative materials are possible, although with less-preferred functionality and/or economics.. The narrow value chain analysis includes only the value of the nickel-containing alloy (e.g. stainless steel) used in these applications, not the value of the end-use application itself (e.g. cutlery).

Examples of "less critical" applications include:

- Transport: Railway (railcars), bicycles, shipbuilding, and many automotive applications (including engine parts and trim);
- Electro and Electrical: Washing machines, dishwashers, freezers, refrigerators, domestic cookers, and other appliances;
- Engineering: packaging, textiles, pulp and paper process equipment; *and*
- Metal Goods: cutlery, tableware, fasteners (screws, bolts & nuts), coinage.

Estimates of the additional value-added and employment effects of these less critical sectors have been included in the broad value chain.

This was done using a two-pronged approach, which produced a range of estimates:

- **"Limited value-added".** All less critical applications were assumed to create a limited amount of value-added (and hence jobs) during the "End Use" production process.
- **"Significant value-added".** Less critical sectors were assumed to create as much value-added as the critical sectors. Hence, the less critical "End Use" sectors were valued at the same stage of the production process as the critical applications.

## 4. KEY FINDINGS

### 4.1. Overview of the Nickel Value Chain

The EU is a major user of nickel. Total European use in 2002 was more than 700kt, which represented around 40% of global demand. This demand is satisfied through a combination of EU production of refined nickel, imports, and recycling of existing nickel-containing products within the EU.

Whilst the EU nickel industry itself is relatively small, it has a significant impact on the EU economy through its value chain. Through its critical use in nickel-containing alloys, it has a major impact on leading EU industries such as stainless steel. In turn, the use of nickel-containing alloys in many important products manufactured in Europe means that the impact of nickel is substantial in many end-use markets.

As a consequence, the total value-added produced by the "Direct Nickel Industry" and its narrow value chain in the EU is estimated to be Euro 40 billion (Exhibit 5)[17].

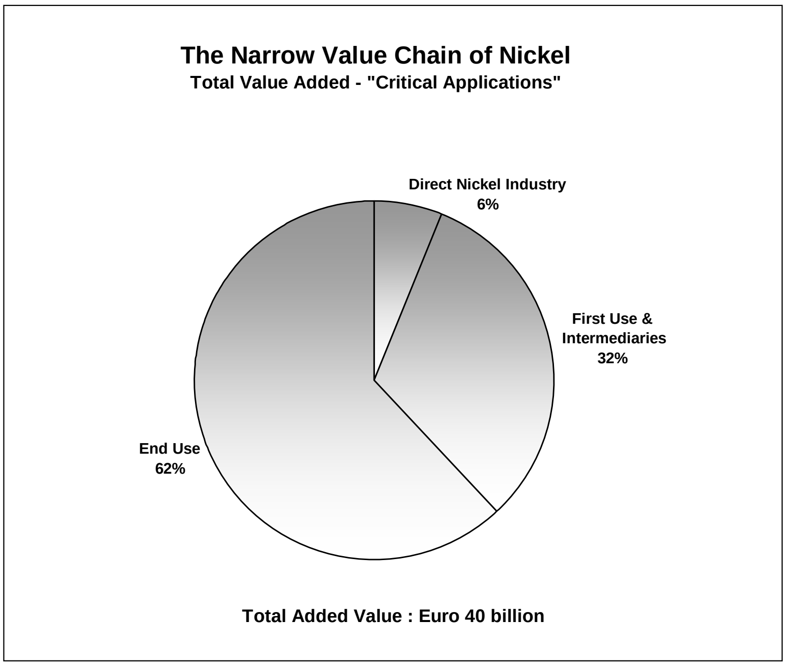


**Exhibit 5: The Narrow Value Chain of Nickel: Total Value Added (Critical Applications)**
Source: THE WEINBERG GROUP

Taking account of the broad nickel value chain (including less critically dependent applications), the total value-added produced by the nickel industry and its broad value chain in the EU is estimated to be in the range Euro 80-100 billion (Exhibit 6).

[17] Annex C Table 1 refers

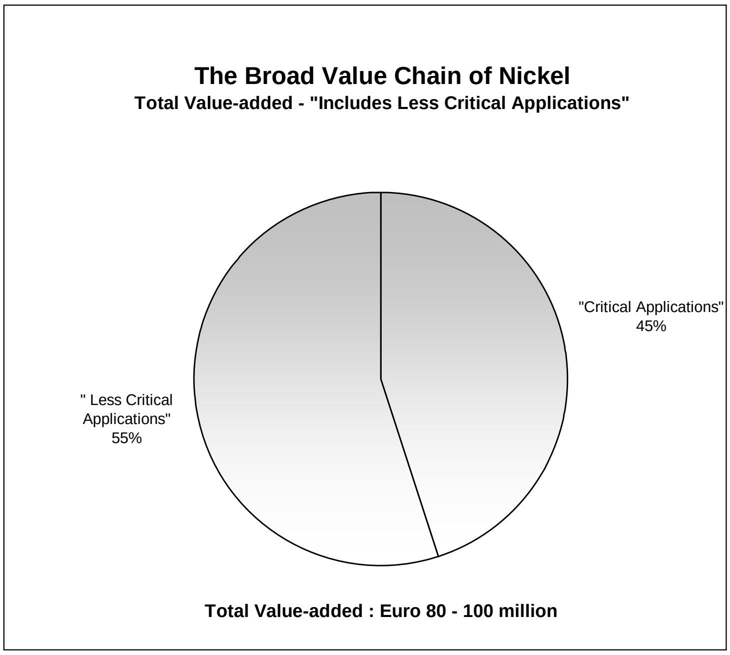


**Exhibit 6: The Broad Value Chain of Nickel: Total Value Added (Includes "Less Critical Applications")**
Source: THE WEINBERG GROUP

The "Direct Nickel Industry" and the industries in its value chain that are *critically dependent* upon it, employ a substantial number of people. It is estimated that 475,000 people are employed in the EU by the nickel industry, "First Use" and "End Use" product manufacturers who are critically dependent on nickel.

Moreover, the nickel industry and its value chain create additional employment in the economy through capital expenditure and income and supplier "multiplier" effects, as each euro of expenditure on goods and services by companies in the nickel industry and its value chain generates additional employment in other sectors, especially services. It is estimated that employment associated with capital expenditure across the value chain amounts to 25,000 and the multiplier effect accounts for around 200,000 additional jobs in the wider economy.

Hence 700,000 jobs in the EU are *critically dependent* on the nickel industry and its narrow value chain (Exhibit 7)[18].

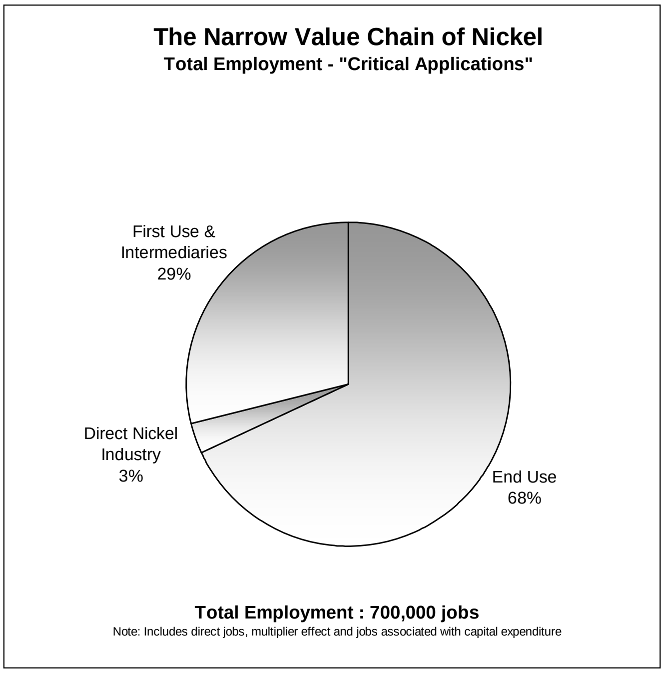


**Exhibit 7: The Narrow Value Chain of Nickel: Total Employment ("Critical Applications")**
Source: THE WEINBERG GROUP

[18] Annex C Table 1 refers

Taking account of the broad nickel value chain, total employment by the nickel industry and its broad value chain is estimated to be in the range 1.25-1.5 million (Exhibit 8).

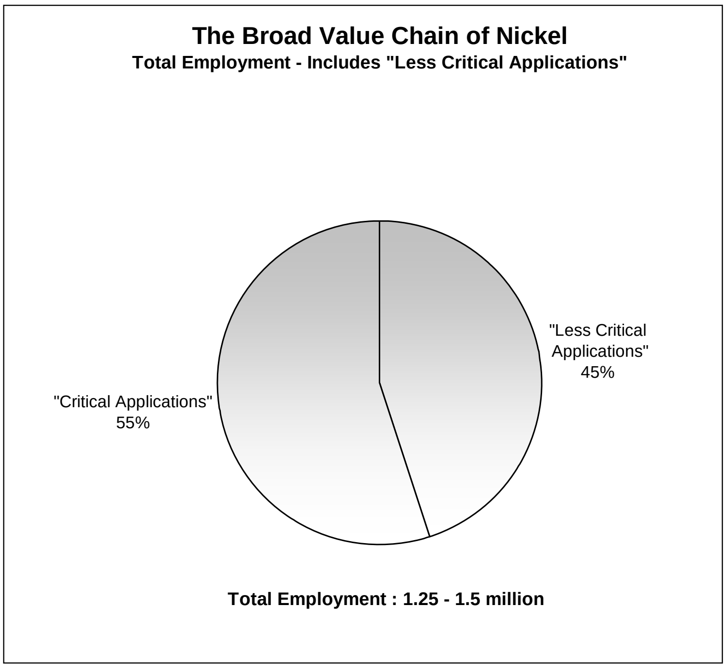


**Exhibit 8: The Broad Value Chain of Nickel: Total Employment (Includes “Less Critical Applications”)**
Source: THE WEINBERG GROUP

Many of these jobs are high skill manufacturing jobs, particularly those in nickel refineries and stainless steel plants. Others are a mix of high skill and lower skills. For example, “End Use” sectors such as jet engine manufacturing employ large numbers of highly skilled managers, researchers and production workers. Others, such as metal fabricators producing tubes and pipes for use in process industries employ a greater proportion of lower skilled people.

Salaries and wages paid by the nickel industry and narrow value chain to these employees amount to an estimated Euro 20 billion[19].

The industry and its narrow value chain also contribute significantly to Europe’s economy through high levels of investment:

- Capital expenditure amounts to an estimated Euro 2.6 billion per annum, equivalent to nearly 1.5% of annual manufacturing investment in the EU.

- Investment in R&D throughout the nickel value chain is estimated to be Euro 2 billion per annum, equivalent to 2% of annual R&D expenditure by business in the EU (Exhibit 9)[20].

[19] Annex C Table 12 refers
[20] Annex C Table 1 refers

**Exhibit 9: The Narrow Nickel Value Chain: Investment in Capital Expenditure and R&D**
Source: THE WEINBERG GROUP

The nickel industry and its narrow value chain also account for substantial tax revenues:

- It is estimated that around Euro 10 billion is paid by employees and employers in employment taxes (income taxes and social charges), and

- The nickel industry pays an additional net Euro 4 billion in sales taxes (Exhibit 10)[21].

[21] Annex C Table 1 refers

Companies in the value chain also pay corporation tax and other local taxes.

**Exhibit 10: The Narrow Nickel Value Chain: Taxes Paid**
Source: THE WEINBERG GROUP

## 4.2. The "Direct Nickel Industry"

### *4.2.1. EU Nickel Use*

Over the last 20 years, the use of nickel in Europe has expanded substantially as many new uses of nickel have been developed (Exhibit 11). Growth has been particularly strong in recent years in automotive applications, consumer electronics, commercial catering and construction.

**Exhibit 11: EU Use of Nickel (2002)**
Source: Heinz Pariser "End Uses of Nickel" (2003)

The EU market is currently growing at 3-5% per annum. This means that the intensity of nickel use in the EU is also growing, as nickel use is expanding faster than GDP.

The largest market in Europe is Germany (23%) followed by Italy (16%), France and Spain. Sweden, UK, Belgium and Finland also represent significant markets (Exhibit 12).

**Exhibit 12: EU Use of Nickel (by country) (1990 – 2003)**
Source: Heinz Pariser "End Uses of Nickel" (2003) and THE WEINBERG GROUP

### *4.2.2. EU Supply*

The nickel industry in the EU operates in a highly competitive, international environment. Competition is global stretching from Europe, USA, and Japan and encompassing the emerging economies of Asia.

A key feature of the global nickel industry is the London Metal Exchange (Exhibit 13).

**Exhibit 13: The London Metal Exchange**
Source: THE WEINBERG GROUP

Demand in Europe is satisfied through a combination of EU production of refined nickel, imports of refined nickel, and recycling of existing nickel (Exhibit 14)[22].

**Exhibit 14: EU Nickel Demand and Supply Balance**
Source: INSG "World Nickel Statistics" (2003), NiDI and THE WEINBERG GROUP

Indigenous production of nickel is relatively small in the EU – in terms of mining *and* refining.

- Raw material for the refining process is predominantly imported from outside the EU, mainly from Canada, but also from Botswana, New Caledonia, Brazil and Australia.

  The only significant mining activities within Europe are at Evia, Agios and Kastoria in Greece, which account for 18% of raw material input. There is also a small mine at Hitura in Finland that has been closed and re-opened several times. Total production from EU mines in 2002 amounted to 25.2 kt (Nickel Units) - 2.7 kt from Greece and 2.5 kt from Finland. Output from nickel mines in Europe has been relatively stable over the last five years.

- There are five smelters/refineries in the EU producing a total of 120kt (Nickel Units), satisfying 17% of EU demand. The principal plants are located at Harjavalta in Finland (producing 55kt), Clydach in the UK (33 kt), Larymna in Greece (19 kt), and Sandouville in France (11 kt)[23]. European refineries are now operating close to their current optimum capacities so major increases in European refined nickel production in the future will depend on investments[24].

  The nickel refining industry is dominated by a small number of large-scale, multi-national enterprises, most of which are also major investors in mining businesses. Refining plants utilise complex production technologies that are highly capital-intensive and operate within a heavily regulated environment. The main costs are raw materials and energy (over 50% of revenues), skilled labour (15% of revenues), and the replacement and financing of capital (20% of revenues)[25].

- Substantial quantities of refined nickel are imported into the EU. In 2002, imports exceeded 300 kt (Nickel Units), satisfying over 40% of EU nickel demand. Refined nickel is imported primarily from the Russian Federation, Australia, Canada and Norway.

- The remainder of EU demand (circa 40%) is satisfied through recycling of scrap (particularly stainless steel scrap).

  The majority of this recycled nickel (70% of Nickel Units) is derived from scrap collected from within Europe.

[22] Annex C Tables 2, 3 and 4 refer
[23] Annex C Table 3 refers
[24] Source: NiDI (2002)
[25] Brooke Hunt 'Nickel Industry Costs to 2015' (2003)

The remaining 30% comes from imported scrap, largely from the Russian Federation.

Exhibit 15 describes the nickel recycling industry.

**Exhibit 15: Nickel Recycling**
Source: THE WEINBERG GROUP

Nickel flows are summarised in Exhibit 16.

It shows that, in the EU, in 2002:

- Total nickel balance was: 718kt;
- Total sources were: new nickel (425kt) and re-cycled nickel (293kt);

- Total uses were: domestic (EU) use (340kt); exports (255kt); scrap for recycling (123kt).

**Exhibit 16: Nickel in the EU 2002: Nickel Flows**
Source: NiDI (2002)

### *4.2.3. Value Added*

The "Direct Nickel Industry" produces Euro 2.5 billion in value-added in Europe. Only 20% of this comes from the primary nickel miners and refiners[26].

Around 80% of the total value-added of the direct industry in Europe (Euro 2 billion) comes from nickel recycling activities. This reflects the high recovery rate of nickel from scrap collected within the EU.

### *4.2.4. Employment, Salaries and Wages*

Employment within the "Direct Nickel Industry" in Europe is relatively small at 13,000, a quarter of whom are associated with primary nickel activities and three quarters of whom are engaged in recycling activities. This includes both the people employed directly and those employed indirectly in activities that have been out-sourced to third party suppliers, such as logistics.

In addition, the direct industry created a further 1,000 jobs associated with its capital expenditure and an additional 5,000 jobs in the economy through "multiplier" effects.

Hence nearly 20,000 jobs are dependent on the "Direct Nickel Industry" in the EU[27].

Salaries and wages paid to people working in the "Direct Nickel Industry" are estimated to be Euro 0.5 billion[28].

### *4.2.5. Investment in Capital and R&D*

The "Direct Nickel Industry" invests an estimated Euro 25 million in R&D and Euro 75 million per annum in capital[29].

Moreover, total capital employed in the industry is estimated to be around Euro 2 billion, reflecting the high capital intensity of the primary refining industry and the relatively low capital intensity of the recycling industry[30].

### *4.2.6. Taxes Paid*

Taxes and social security charges paid by employees on salaries and wages and social security charges paid by employers in the direct industry are estimated to be in excess

[26] Annex C Table 2 refers
[27] Annex C Table 2 refers
[28] Annex C Table 12 refers
[29] Annex C Tables 14 and 15 refer
[30] Annex C Table 14 refers

of Euro 300 million[31]. In addition, it is estimated that companies operating in the "Direct Nickel Industry" pay a net Euro 350 million in sales taxes[32].

Companies also pay corporation taxes and local property taxes.

## 4.3. "First Use"[33]

### *4.3.1. "First Use" Sectors*

The main primary uses of nickel are in the production of nickel-containing alloys (stainless steel, alloy steels, non-ferrous alloys; and foundry products) nickel plating and "other" products such as nickel cadmium batteries, chemicals and catalysts. (Exhibit 17)

[31] Annex C Table 12 refers
[32] Annex C Table 13 refers
[33] This section concentrates on the critically dependent applications included in stage one of the nickel value chain

**Exhibit 17: "First Use" Sectors: Nickel Used**
Source: NiDI (2002)

Nearly three-quarters of all nickel use is concentrated in the stainless steel product ranges[34], where nickel is a critical "enabling technology", which facilitates a number of key benefits for stainless steel producers, such as corrosion resistance, formability and weldability. These benefits, combined with low life cycle costs, have resulted in a major growth (6% per annum) in the production and use of stainless steel over the last 20 years, despite competition from other materials (Exhibit 18).

[34] Annex C Table 5 refers

**Exhibit 18: Market Growth: World Production of Stainless Steel 1980 - 2002**
Source: INCO "World Stainless Steel Statistics" (2002)

The European Union is the global leader in the stainless steel sector because of its investment in large-scale facilities and in process innovation. The EU produced 20 million tonnes of stainless steel (or 40% of world production) in 2002. EU based companies are also market leaders, with around 50% share of worldwide markets. The four leading EU companies (Arcelor with its HQ in France, ThyssenKrupp with its HQ in Germany, AvestaPolarit with its HQ in Finland, and Acerinox with its HQ in Spain) are also the four largest stainless steel companies in the world.

Major stainless steel plants are located in Austria (Linz), Belgium (Genk), Finland (e.g. Tornio and Imatra), France (e.g. Isbergues, Fos-sur-Mer and Geugnon), Germany (e.g. Krefeld and Bochum), Italy (e.g. Terni and Turin), Spain, (e.g. Palmones, Ponferrada, and Iqualadda), Sweden (e.g. Avesta) and the UK (Sheffield). Many of these plants are in lagging regions.

The stainless steel business is highly competitive, capital-intensive, and dominated by large-scale production facilities. Complex production technologies combined with expensive equipment and the need for high levels of productive efficiency all contribute to the need for high levels of capital investment in each plant.

On average, a modern world-class plant has annual production in excess of more than 1 million tonnes and requires total investment in excess of Euro 1.3 billion. This is equivalent to one Euro of capital for each Euro of sales revenues.

The principal costs of the stainless steel industry are raw materials and energy (50-60% of revenues; skilled labour (15% of revenues); and financing and replacement of capital (20% of revenues)[35]. Exhibit 19 summarises the cost structure for an archetype stainless steel plant.

**Exhibit 19: Archetype Stainless Steel Plant: Analysis of Costs**
SOURCE: THE WEINBERG GROUP (2003)

Whilst multi-national companies dominate the stainless steel sector, the nickel plating sector is dominated by SMEs. As part of the surface engineering industry, it forms a critical element of the industrial base needed to support modern manufacturing in the EU. Over 70% of all manufacturing output is coated in some way, and plating is one of the most important coating technologies.

Again nickel is a critical "enabling technology" facilitating a number of key benefits to plated products. It is used to provide resistance to corrosion and wear, to achieve a strong decorative finish, and to create functional products. It helps to transform critical components used, for example, in automotive, aerospace, marine, domestic appliance, and electronic applications are transformed.

The plating sector is highly fragmented in the EU. It is estimated that there are 2,000 businesses in the EU that provide a plating service based on a nickel-containing alloy. Ninety-five per cent of these are SMEs with less than 50 employees, and more than half of these businesses have less than 10 employees. Plating companies operate in all Member States, but 85% are concentrated in France, Germany, Italy, Spain and the UK.

"Intermediaries" also play an important role in "First Use" industries:

- Distributors provide smaller users with access to a range of stainless steels in accessible quantities. They act to break down the large batches of flat products produced by the main manufacturers into smaller quantities. They also provide inventory and logistics services.

  Within the EU around 60% of stainless steel is supplied through distributors. Although some distributors are subsidiaries of the major producers of stainless steel, many are independent businesses, including a large number of SMEs.

- Finishers (including fabricators, metal formers, and surface engineering businesses) also play an important role, providing specialist finishing services to users of stainless steel. Again, most of these businesses are SMEs.

### *4.3.2. Value-Added*

"First Use" industries produce nearly Euro 9 billion in value-added in Europe, based on the critically dependent applications included in the narrow value chain. The

[35] Moll M "Stainless Steel Production Costs" (1999, Third European Stainless Steel Congress - Proceedings

majority of this comes from stainless steel, which produced nearly Euro 6 billion in value-added in 2002.

"Intermediaries" produce a further Euro 4 billion, making a total of Euro 13 billion value-added from this tier of the narrow value chain for nickel (Exhibit 20)[36].

[36] Annex C Tables 5, 6, 7, 8 and 9 refer

**Exhibit 20: "First Use" Sectors: Value Added (Narrow Value Chain)**
Source: THE WEINBERG GROUP

This is a conservative estimate of value-added because ferritic (non-nickel containing) stainless steel and non-nickel plating have been excluded from the narrow (critically dependent) analysis of the nickel value chain.

Including them in the broad value chain of nickel (on the grounds that the economics of both segments depend on nickel), it is estimated that value-added by the "First Use" sector of the wider nickel value chain would be Euro 5 billion greater at Euro 18 billion.

### *4.3.3. Employment, Salaries and Wages*

Employment in "First Use" industries that are critically dependent on nickel is estimated at around 75,000 people. This includes both the people employed directly by the "First Use" industries and those employed indirectly in activities that have now been outsourced to third party suppliers. Again, the majority of these are employed in the stainless steel industry.

"Intermediaries" are estimated to employ a further 60,000 across the EU.

In addition, "First Use" industries created a further 10,000 jobs through their annual capital expenditure programmes and a further 55,000 jobs in the economy as a whole through "multiplier" effects.

Hence around 200,000 jobs overall are critically dependent on nickel in the “First Use” sector of the narrow value chain (Exhibit 21)[37].

**Exhibit 21: “First Use” Sectors: Employment (Narrow Value Chain)**
Source: THE WEINBERG GROUP

Including ferritic (non-nickel containing) stainless steel and non-nickel plating in the broad value chain of nickel (on the grounds that the economics of both segments depend on nickel), it is estimated that employment would be around 70,000 greater at 270,000 in the wider “First Use” sector of the value chain.

Moreover, many “First Use” plants (such as stainless steel) are large in scale. This means that the employment effect on local communities is significant as they represent a large proportion of local jobs. Indeed, in some regions, they are critical to the well being of local communities.

Salaries and wages paid to people working in “First Use” industries and “Intermediaries” of the narrow value chain of nickel are estimated to be around Euro 6 billion[38].

[37] Annex C Tables 5, 6, 7, 8 and 9 refer
[38] Annex C Table 12 refers

#### 4.3.4. Exports

Twenty-five per cent of EU production is exported, making the EU the world's leading exporter of stainless steel and. The overall value of net exports of stainless steel from the EU in 2002 was approximately Euro 3 billion[39].

Major exporting countries include Belgium, Finland, France, Germany, Italy, and Sweden. Main destinations include Asia (particularly China and Taiwan), Eastern Europe and North and South America.

High nickel alloys are also exported from the EU – mostly from France Germany, and the UK.

#### 4.3.5. Investment in Capital and R&D

"First Use" industries in the narrow value chain of nickel invest an estimated Euro 200 million in R&D and Euro 1 billion in capital per annum[40].

Moreover, total capital employed in the industry is estimated at Euro 20 billion, reflecting the high capital intensity of industries such as stainless steel[41].

#### 4.3.6. Taxes Paid

Taxes and social security charges paid by employees on salaries and wages and social security charges paid by employers in "First Use" industries are estimated to be in excess of Euro 3 billion[42] in the narrow value chain. In addition, it is estimated that companies operating in the "Direct Nickel Industry" pay a net Euro 1.5 billion in sales taxes[43].

Companies also pay corporation taxes and local property taxes.

#### 4.3.7. Cluster Benefits

Leadership in "First Use" industries has also led to the development of "cluster benefits"[44] for the EU.

The European stainless steel sector, for example, can be characterised as a successful, mature cluster of firms that is stimulated by leading-edge demand from users. It is supported by a highly developed "innovation system" supplying leading-edge ideas, high quality skills, and advanced supplier industries.

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[39] Heinz Pariser "EU Trade of Stainless Steel" (2003)
[40] Annex C Table 14 refers
[41] Annex C Table 14 refers
[42] Annex C Table 12 refers
[43] Annex C Table 13 refers
[44] Clusters evolve in response to the presence of a small number of key factors, such as demanding customers, availability of key resources (such as skills and knowledge) high quality related and supporting industries, and competitive intensity between firms within the cluster. In turn, competitive and successful clusters also stimulate additional demand for key resources and supporting industries. See Porter "The Competitive Advantage of Nations" (1990) and US Council on Competitiveness "The New Challenge to America's Prosperity" (1999)

Indeed, some of these supplier industries have themselves become world leaders.

- Virtually all of the world's stainless steel plants are designed and built by EU companies. These include: SMS–Demag (a German company, with its HQ in Düsseldorf and other European bases in Italy and Spain); DMS (a French company, based in Lille); Andritz/Sundwig (an Austrian-German-Dutch company with major facilities in Austria, Germany, and The Netherlands); and Voest Alpine Industries – VAI (an Austrian company with facilities in France, Spain and the UK).

- EU companies dominate the supply of automation and electrical components to the stainless steel industry. The leaders include ABB (Sweden-Switzerland), Alstom (France), Ansaldo (Italy), and Siemens (Germany).

Successful clusters also sustain an effective "innovation system" for creating and disseminating knowledge.

- Joint development work (with academics in universities and research institutions and with other companies) plays an important role in helping to sustain the wider knowledge base of the EU. It also has substantial benefits for the education of EU graduates.

- These activities are supported by specialist external and in-house research facilities in most countries of the EU.

## 4.4. "End Use" [45]

### *4.4.1. "End Use" Applications*

Nickel-containing alloys are used in a wide range of products, but the analysis of the narrow value chain of nickel is confined to those "End Uses" that are *critically dependent on nickel*. "End Use" applications have been included only where the nickel-containing alloy *significantly transforms* the production process or the end product, *and* where it would be difficult to achieve this satisfactorily any other way[46].

Thirteen "End Use" applications have been identified that are *critically dependent on nickel*.

- Many of these critically dependent "End Use" sectors are vitally **important to the EU economy**. In some, such as aerospace jet engines and industrial and marine gas turbines, European companies such as Rolls Royce (UK), Snecma (France) and Siemens (Germany) are amongst the world leaders in these sectors.

[45] This section concentrates on the critically dependent stage one of the nickel value chain
[46] See section 2.4 for a list of the "End Use" applications and a justification for the inclusion of each

- Other critically dependent "End Use" sectors have **large numbers of employees** in the EU. One example is the use of nickel-containing alloys in the production of process plant equipment for the food and drink, oil and gas production, petroleum refining, chemicals and pharmaceuticals industries.

- Others are **technological leaders**. For example, in the High Precision Replication niche where electro-formed screen printing rolls are produced for manufacturers of wallpapers, carpets and textiles, Stork (based in The Netherlands) is a technological world leader in this niche market.

The split between critical (22.5%) and less critical (77.5%) applications is shown in Exhibit 22.

| **Sector** | **Total Nickel Used (kt)** | **Critical Applications (kt)** | **Less Critical Applications (kt)** |
|---|---|---|---|
| Transport | 50.5 | 14.6 | 35.9 |
| Electro-electronic | 34.8 | 1.1 | 33.7 |
| Engineering | 89.8 | 51.9 | 37.9 |
| Building & construction | 32.1 | 0 | 32.1 |
| Tubular Products | 48.0 | 0 | 48 |
| Metal Goods | 36.2 | 9.3 | 26.9 |
| Other | 48.6 | 0 | 48.6 |
| **Total** | **340.0** | **76.9** | **263.1** |

**Exhibit 22: Critical and Less Critical Applications of Nickel**
Source: THE WEINBERG GROUP

Whilst nickel plays a critical role in each of these thirteen sectors, the cost of the nickel as a proportion of total sales value is very small. In “First Use Sectors”, for example, nickel represents 31% of the sales value, but in the critically dependent “End Use” sectors it represents only 1.5% of sales value. This is illustrated in Exhibit 23[47].

**Exhibit 23: Nickel Cost – Cost of Nickel as a Proportion of Sales Value**
Source: THE WEINBERG GROUP

[47] Annex C Tables5 and 10 refer

### *4.4.2. Value-added*

”End Use” industries that are critically dependent on nickel produce around Euro 25 billion of added-value in the narrow value chain (Exhibit 24)[48].

**Exhibit 24: Value Added in “End Use” Sectors Critically Dependent on Nickel (Narrow Value Chain)**
Source: THE WEINBERG GROUP

The largest *nickel dependent* end-use applications are the use of nickel-containing alloys in process plant equipment (38%) and the use of nickel-containing “super alloys” in jet engines (25%).

- Nickel-containing alloys have become the materials of choice in much process industry equipment where exacting standards and difficult operating environments mean that the specific properties of nickel are crucial.

- In aerospace, on the other hand, nickel-containing super alloys are essential to the successful operation of the aerospace gas-turbine engine, as only these alloys provide the combination of properties that withstand the very high stresses, rotational speeds and temperatures experienced by critical components in the engine.

[48] Annex C Table 10 refers

The narrow value chain includes only those “End Use” applications that are *critically dependent* on nickel. If all “End Use” applications of nickel were included, it is estimated that value-added would be between Euro 35-55 billion greater (depending on the valuation approach used), making a total value-added by the broad value chain for the “End Use” sector of between Euro 60-80 billion.

### *4.4.3. Employment, Salaries and Wages*

It is estimated that “End Use” sectors that are critically dependent on nickel employ around 325,000 people in the EU.

The largest employers are the producers of process plant equipment (140,000) and the manufacturers of jet engines (55,000). But commercial catering equipment suppliers (45,000) and CD/DVD pressing plants (30,000) are other important employers in the EU.

In addition, ”End Use” sectors that are critically dependent on nickel create an additional 20,000 jobs through the effect of their annual capital expenditure, and a further130,000 jobs in the economy through “multiplier” effects.

Hence the total employment effect of “End Use” sectors that are *critically dependent* on nickel is of the order of 475,000 (Exhibit 25)[49].

**Exhibit 25: Employment in “End Use” Sectors Critically Dependent on Nickel (Narrow Value Chain)**
Source: THE WEINBERG GROUP

[49] Annex C Table 10 refers

By including all “End Use” applications of nickel, it is estimated that employment would be 0.5-0.7 million higher (depending on the valuation approach used). This means that the broad nickel value chain for the “End Use” sector might employ between 1.0-1.2 million people.

### *4.4.4. Investment in Capital and Salaries and Wages*

“End Use” sectors that are critically dependent on nickel invest an estimated Euro 2 billion in R&D and Euro 1.5 billion in capital per annum[50].

Moreover, total capital employed in these industries is estimated to be around Euro 25 billion[51].

### *4.4.5. Taxes Paid*

Taxes and social security charges paid by employees on salaries and wages and social security charges paid by employers in “End Use” industries that are critically dependent on nickel (the broad value chain) are estimated to be Euro 7 billion[52]. In addition, it is estimated that companies pay a net Euro 2 billion of sales taxes[53].

Companies in these industries also pay corporation taxes and local property taxes.

[50] Annex C Tables 14 and 15 refer
[51] Annex C Table 14 refers
[52] Annex C Table 12 refers
[53] Annex C Table 13 refers

## 5. CONCLUSIONS

The nickel industry is a relatively small industry that has a major impact on a number of important industries in its value chain.

Whilst it produces only Euro 2.5 billion in value-added and employs only 13,000 people *directly*, it is estimated that over Euro 40 billion of value-added and 700,000 jobs in Europe are *critically dependent* on nickel. Taking the *broad* value chain into account, it is estimated that Euro 80-100 billion of value-added and 1.25-1.5 million jobs may be dependent on nickel.

This is because nickel is a critical "enabling technology" in the production of nickel-containing alloys, such as stainless steel. It confers unique performance characteristics on these alloys such that they, in turn, significantly transform the production process of the finished product in a number of important "End Use" sectors in Europe.

The EU is the global leader in the production of nickel-containing alloys such as stainless steel. Investment in large-scale facilities and process innovation has helped the EU to become the world's biggest producer and EU companies to become market leaders. Moreover, leadership in "First Use" industries has also led to the development of "cluster benefits" for the EU. Supplier industries, such as the plant building industry, have themselves become global leaders, and a highly developed "innovation system" now exists supplying leading edge ideas to the industry.

A number of important "End Use" sectors in Europe are *critically dependent* on nickel. These include the manufacture of jet engines, the production of process plant equipment used in important industries such as food and drink, oil, chemicals and pharmaceutical production, and the pressing of CDs and DVDs. Their products have a very significant impact on European society.

Moreover, companies in the nickel industry and its value chain invest substantially in the EU through R&D and capital expenditure. They also pay significant amounts in tax in the form of employment taxes, sales taxes and corporate taxes.

# ANNEX A

# GLOSSARY OF TERMS

## GLOSSARY OF TERMS

| | |
|---|---|
| **Capital Employed** | Capital employed is a measure of the financial resources dedicated to supporting business activity. It comprises equity and debt capital used to fund fixed assets (as defined above) and net current assets (including trade debtors and stocks less trade creditors). |
| **Capital Expenditure** | Capital expenditure refers to the value of fixed assts (such as land buildings, transport equipment, machinery and other equipment) purchased. |
| **Employment** | Employment refers to jobs that are dependent on nickel. These include both direct employees and sub-contracted jobs. They are calculated, in the main, using relevant sales per employee ratios. |
| **ENiG** | European Nickel Group; represents, at a European level, the interests of the European nickel supply industry and a portion of the European nickel-using industry. ENiG members include all EU producers of nickel, most major exporters of nickel to the EU and important producers of nickel-based alloys. ENiG is associated with Eurometaux. The ENiG Risk Assessment Team seeks to bring together those nickel producers and importers who are legally governed by the existing substances regulation for risk assessment, together with several of the main downstream users of the priority listed nickel risk assessment substances. This group seeks to organise, and where necessary fund, an effective industry input for the EU risk assessment process. |
| **Multiplier** | Each Euro of expenditure on goods and services by companies and employees in a specific industry generates additional employment in other sectors, especially services. This is known as the “multiplier” effect. |
| **NiDI (Nickel Development Institute)** | Encourages the effective and appropriate use of nickel by society. NiDI provides focused technical and economic information to commercial decision-makers – especially engineers, researchers, architects, designers – to stimulate the development and application of nickel-related products and processes. NiDI is also developing information about the nickel life cycle for wider audiences in the context of sustainable development, including information relating to recycling and life cycle assessment. NiDI operates an active product stewardship policy on behalf of its members. NiDI has been supporting the Risk Assessment Project Team by providing statistics and advice on the wide variety of uses of nickel in the EU. |
| **OECD** | Organisation for Economic Co-operation and Development. |
| **Sales** | This refers to the value of production. It is calculated, in the main, by multiplying volumes produced by average selling prices. |

| | |
|---|---|
| **Taxes** | Taxes, in this instance, refer to employment taxes paid by both the employee (income tax and social charges) and by the employer (social charges) and to sales taxes paid by companies. Sales taxes are calculated net of input value added taxes recovered by companies. They exclude corporate taxes. |
| **Value Added** | Value added, in this instance, is a measure of the contribution of nickel to Europe's economy. It is calculated at each stage of the value chain by taking the value of production in the EU and deducting the value of inputs from the previous stage in the value chain and imports from outside the EU. |

# ANNEX B

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# BIBLIOGRAPHY

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# ANNEX C

# EU VALUE CHAIN - DATA

**Table 1**

## Summary of the Nickel Value Chain in the EU

| | **Value Added** Euro M | **Jobs** | **Jobs Multiplier Effect** | **Jobs Capex Effect** | **Total Jobs** | **Total Salaries & Wages Euro M** | **Total Employment Taxes Euro M** | **Total Sales Taxes Paid Euro M** | **Total R&D Expenditure Euro M** | **Total Capital Expenditure Euro M** | **Total Capital Employed Euro M** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Direct Nickel Industry | 2,600 | 13,000 | 5,000 | 1,000 | 19,000 | 500 | 300 | 350 | 25 | 75 | 2,000 |
| First Use & Intermediaries | 13,000 | 132,000 | 52,000 | 11,000 | 195,000 | 6,000 | 3,000 | 1,500 | 200 | 1,000 | 19,000 |
| End Use | 25,000 | 320,000 | 130,000 | 18,000 | 468,000 | 14,000 | 6,700 | 1,850 | 1,825 | 1,525 | 23,000 |
| **Total** | **40,600** | **465,000** | **187,000** | **30,000** | **682,000** | **20,500** | **10,000** | **3,700** | **2,050** | **2,600** | **44,000** |

## Nickel: Direct Industry in the EU

**Table 2**

| | (1) **Sales Volume** kte | (2) **Sales Value** Euro M | (3) **Value Added in Europe** Euro M | (4) **Total Direct Jobs** | (5) **Jobs Multiplier Effect** | (6) **Total Jobs** | **Basis of Sales Value** | **Basis of Added Value** | **Basis of Employment** |
|---|---|---|---|---|---|---|---|---|---|
| Mining | 25 | 119 | 119 | 885 | 354 | 1,239 | 75% of LME = Euro 4750 | All of sales value | See separate sheet (att 1.1) |
| Import of Raw Materials for Refining | | | | | | | | | |
| Ore concentrate | 34 | 162 | 0 | na | | | 75% of LME= Euro 4750 | No added value in Europe | No jobs created in Europe |
| Nickel Matte and Nickel Oxides | 65 | 351 | 0 | na | | | 85% of LME = Euro 5400 | No added value in Europe | No jobs created in Europe |
| Importers Margin | 99 | 10 | 10 | 50 | 20 | 69 | 1-2% of LME + say Eur100/te | Importers margin only | Sales per employee = Euro 200k |
| Smelting/Refining | 121 | 767 | 136 | 1,700 | 680 | 2,380 | LME = Euro 6,340/te | Sales value less mining & imports | See separate sheet (Att 1.1) |
| Trading and Importation | | | | | | | | | |
| Margin on Imports of Nickel | 304 | 30 | 30 | 152 | 61 | 213 | Importers Margin = 1-2% of LME | All of sales value | Sales per employee = Eur 200k |
| Paper trading/broking on LME | na | na | 90 | 170 | 68 | 238 | | | |
| Transport & Logistics | | | | | | | | | |
| Primary Nickel | 425 | 43 | 43 | 425 | 170 | 595 | 1-2% of LME = Eur 100/te | All of sales value | Sales per employee = Eur100k |
| Recycled Nickel (Blenders + Imports) | 170 | 17 | 17 | 170 | 68 | 238 | Eur 100/te for Processors + Imports | All of sales value | Sales per employee = Eur100k |
| Recycling (7) | 293 | 2,870 | 2,180 | 9,400 | 3,760 | 13,160 | See separate sheet | See separate sheet | See separate sheet (Att 1.2) |
| **TOTAL** | | | **2,624** | **12,952** | **5,181** | **18,132** | | | |

## Mining and Refining in the EU

**Table 3**

| Country | Company | Location | Annual Production 2002 kte | (2) Salaried Jobs | (3) Sub-Contracted Jobs | Total Direct Jobs |
|---|---|---|---|---|---|---|
| ***Mining*** | | | | | | |
| Greece | Larco | Evia, Agios, Kastoria | 22.7 | 415 | 395 | 810 |
| Finland | Outokumpu | Hitura, Narvik | 2.5 | 70 | 5 | 75 |
| ***Total EU*** | | | ***25.2*** | ***485*** | **400** | **885** |
| Norway | | | 1.7 | 40 | 5 | 45 |
| **TOTAL EU/EEA** | | | **26.9** | **525** | **405** | **930** |
| ***Smelting/Refining*** | | | | | | |
| Austria | Treibacher | | 1.5 | 25 | 2 | 27 |
| Finland | OMG | Harjavalta | 55.3 | 200 | 100 | 300 |
| France | Eramet | Sandouville | 11.4 | 200 | 40 | 240 |
| Greece | Larco | Larymna | 19.2 | 565 | 230 | 795 |
| UK | Inco | Clydach | 33.3 | 260 | 55 | 315 |
| ***Total EU*** | | | ***120.7*** | ***1,250*** | **427** | **1,677** |
| Norway | Falconbridge | Kristiansand | 68.5 | 550 | 25 | 575 |
| **TOTAL EU/EEA** | | | **189.3** | **1,800** | **452** | **2,252** |

## Recycling in the EU

**Table 4**

| | (1)<br>**Sales Volume (Ni units)**<br>kte | (2)<br>**Sales Volume Ni containing St Steel Scrap** | *(3)*<br>***Sell-Out Price Achieved***<br>*Euro/te* | **(4)**<br>**Sales Value**<br>**Euro M** | **(5)**<br>**Value Added in Europe**<br>**Euro M** | *(6)*<br>***Labour Costs***<br>*Euro/te* | (7)<br>**Total Labour Costs**<br>Euro M | *(8)*<br>***Labour Cost per person***<br>*Euro K* | **(9)**<br>**Jobs** |
|---|---|---|---|---|---|---|---|---|---|
| Collectors | 59 | 656 | *704* | **462** | **462** | *170* | 111 | *25* | **4,458** |
| Dismantlers | 23 | 256 | *704* | **180** | **180** | *135* | 35 | *25* | **1,380** |
| Fabricators & Service Centres Scrap | 40 | 444 | *704* | **313** | **313** | *30* | 13 | *30* | **444** |
| [Middlemen] | 122 | 1,356 | *774* | **1,049** | **95** | *5* | 7 | *35* | **194** |
| Imported Scrap | 88 | 978 | *704* | **688** | **na** | *na* | | | **0** |
| [Scrap Processors] | 210 | 2,333 | *882* | **2,058** | **320** | *30* | 70 | *35* | **2,000** |
| Mill Home Scrap | 83 | 922 | *882* | **813** | **813** | *30* | 28 | *30* | **922** |
| **Total EU** | **293** | **3,256** | | **2,871** | **2,183** | | **264** | | **9,398** |

## "First Use" in the EU

**Table 5**

| | (1) *Nickel Units kte* | (2) *Cost of Nickel Input Eur M* | (3) *Average Nickel Content %* | (4) *Total Volume of Metal Based on Ni kte* | (5) *Average Sell-out Price to users Euro/te* | (6) *Value of Ni-based Sales Euro M* | (7) *Value of Imports Euro M* | (8) **Value Added Euro M** | **(9) Salaried Jobs Dependent on Nickel** | **(10) Contracted out Jobs dependent on Nickel** | **Sub-total Direct Jobs** | (11) **Jobs Multiplier Effect** | (12) **Total Employment Dependent on Nickel** | **Notes** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stainless Steel | *507* | *3,214* | *10.5* | *4,800* | *2,000* | *9,600* | *498* | **5,888** | **32,000** | **9,600** | **41,600** | 16,640 | **58,240** | (13) |
| Alloy Steels | *39* | *247* | *1.5* | *2,600* | *600* | *1,560* | *78* | **1235** | **5,200** | **1,560** | **6,760** | 2,704 | **9,464** | (14) |
| Non-Ferrous Alloys | | | | | | | | | | | | | | |
| Nickel Based | *87* | *552* | *50.0* | *174* | *5,000* | *870* | *87* | **231** | **2,900** | **870** | **3,770** | 1,508 | **5,278** | (15) |
| Copper Based | *12* | *76* | *15.0* | *80* | *3,000* | *240* | *36* | **128** | **800** | **240** | **1,040** | 416 | **1,456** | |
| Foundry | *28* | *178* | *5.0* | *560* | *1,000* | *560* | *45* | **338** | **1,867** | **560** | **2,427** | 971 | **3,397** | (16) |
| Plating | *19* | *120* | *na* | *na* | *na* | *1,300* | *130* | **1,050** | **15,300** | **2,295** | **17,595** | 7,038 | **24,633** | (17) |
| [Other] | *26* | *na* | *na* | *na* | *na* | *Na* | *na* | **na** | **na** | **na** | **na** | | **na** | (18) |
| **TOTAL** | ***718*** | ***4,387*** | | ***8,214*** | | ***14,130*** | ***874*** | **8,869** | **58,067** | **15,125** | **73,192** | **29,277** | **102,468** | |
| [Intermediaries] | *na* | *na* | *na* | *na* | *na* | *Na* | *na* | **4,090** | **50,800** | **7620** | **58,420** | 23,368 | **81,788** | (19) |
| **GRAND TOTAL** | ***718*** | ***4,387*** | | ***8,214*** | | ***14,130*** | ***874*** | **12,959** | **108,867** | **22,745** | **131,612** | **52,645** | **184,256** | |

## Nickel Use in the EU Plating Sector

**Table 6**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| **Plating Sectors** | ***Nickel Units (kte)*** | ***Cost of Nickel Input (Euro M)*** | ***Plating Charge (% of Nickel input cost)*** | ***Nickel Plating Revenues (Euro M)*** | ***Non-EU Costs (Euro M)*** | **Value-Added (Euro M)** | ***Sales per employee Euro '000s*** | **Salaried Jobs** |
| Engineering | *4* | *25* | *5* | *507* | *51* | **431** | *85* | **5,967** |
| Decorative | *15* | *95* | *12* | *793* | *79* | **618** | *85* | **9,324** |
| **TOTAL** | *19* | *120* | | *1,300* | *130* | **1,049** | | **15,291** |
| *Nickel Price (Euro te)* | *6,340* | | | | | | | |

## Stainless Steel and Alloy "Intermediaries" in the EU: Summary

**Table 7**

.

| | Salaried Jobs | Value-Added (Euro M) |
|---|---|---|
| **Stainless Steel** | | |
| Distributors | 27,091 | 2,438 |
| Fabricators | 12,504 | 900 |
| Metal Formers | 6,431 | 289 |
| Surface Engineering | 2,701 | 270 |
| ***Sub-total*** | ***48,727*** | ***3,897*** |
| **Alloy Steels** | | |
| Distributors | 2,108 | 190 |
| ***Sub-total*** | ***2,108*** | ***190*** |
| **Non-Ferrous Alloys** | 0 | 0 |
| ***Sub-total*** | ***0*** | ***0*** |
| **Total** | **5,0835** | **4,087** |

## "Intermediaries" in the EU – Distributors

**Table 8**

| | Indirect Sales (kte) | (3) *Purchase Cost* *(Euro te)* | (4) ***Purchase Cost*** ***(Euro M)*** | (5) ***Gross Margin*** ***(% sales)*** | (6) ***Sell-out Price*** ***(Euro te)*** | (7) **Sales Value** **(Euro M)** | (8) **Value-Added** **(Euro M)** | (9) ***Employment*** ***Sales per man (Euro '000)*** | (10) **Employment Salaried Jobs** |
|---|---|---|---|---|---|---|---|---|---|
| Stainless Steel | **2,845** | *2,000* | *5,689* | *30* | *2,857* | **8,127** | **2,438** | *300* | **27,091** |
| Alloy Steels | **633** | *700* | *443* | *30* | *1,000* | **633** | **190** | *300* | **2,108** |
| Non-Ferrous Alloys | **0** | *N/A* | *0* | *N/A* | *N/A* | **0** | **0** | *300* | **0** |
| TOTAL | **3,477** | | *6,132* | | *3,857* | **8,760** | **2,628** | | **29,199** |

| *Indirect Sales (1)* | *Consumption (kte) (2)* | *Indirect Sales (%)* | *Indirect Sales (kte)* |
|---|---|---|---|
| *Stainless Steel* | | | |
| *France* | *477* | *60* | *286* |
| *Germany* | *1,350* | *50* | *675* |
| *Italy* | *1,376* | *50* | *688* |
| *Spain* | *431* | *60* | *259* |
| *UK* | *289* | *75* | *217* |
| *Other Europe* | *900* | *80* | *720* |
| ***Total*** | ***4,823*** | ***60*** | ***2,845*** |
| *Alloy Steels* | | | |
| *EU* | *2,530* | *25* | *633* |
| *Non-Ferrous Alloys* | | | |
| *EU* | | *0* | *0* |

## "Intermediaries" in the EU - Fabricators, Metal Formers & Surface Engineering companies (1)

**Table 9**

| | (3) *Market Size* *(% SSteel Consumption)* | (4) **Market Size** **(kte)** | (5) *Purchase* *Cost* *(Euro M)* | (6) *Gross* *Margin* *(%)* | (7) *Engineering* *Charge* *(% metal cost)* | (8) *Sell-out Price* *(Euro te)* | (9) **Sales Value** **(Euro M)** | (10) **Value-Added** **(Euro M)** | (11) **Sales** **per employee** **(Euro '000)** | (12) **Employment Salaried Jobs** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intermediary Type** | | | | | | | | | | |
| Fabricators | *10* | **482** | *1,350* | *40* | *N/A* | *4,667* | **2,251** | 900 | 180 | 12,504 |
| Metal Formers | *5* | **241** | *675* | *30* | *N/A* | *4,000* | **965** | 289 | 150 | 6,431 |
| Surface Engineering (2) | *10* | **482** | *0* | *N/A* | *20* | *N/A* | **270** | 270 | 100 | 2,701 |
| Total | *25* | **1,206** | *2,026* | | | | **3,485** | 1,460 | | 21,636 |

| | |
|---|---|
| *EU Stainless Steel Consumption (kte)* | *4,823* |
| *Purchase cost from distributors (Euro/te)* | *2,800* |

## “End Use” Applications in the EU that are Critically Dependent on Nickel

**Table 10**

| | (1) **Total End-Use Sales Value** | (2) **Cost of Nickel-containing alloys** | (3) **Cost of Imports** | (4) **Value-Added** | (5) **Sales Per Employee** | (6) **Salaried Jobs in Product Manufacturers** | (7) **Contracted out Jobs** | **Sub-total Direct Jobs** | (8) **Employment Multiplier Effect** | (9) **Total Employment** | **Notes** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Euro M** | **Euro M** | **Euro M** | **Euro M** | **Euro K** | | | | | | |
| ***Nickel Dependent Segments*** | | | | | | | | | | | |
| Automotive Diesel Turbo Chargers | 15,00 | 420 | 150 | 930 | 120 | 12,500 | 6,250 | 18,750 | 7,500 | 26,250 | (10) |
| Aerospace - Jet Engines | 8,000 | 150 | 1,600 | 6,250 | 220 | 36,364 | 18,182 | 54,545 | 21,818 | 76,364 | (11) |
| Industrial and Marine Gas Turbines | 4,000 | 80 | 800 | 3,120 | 220 | 18,182 | 9,091 | 27,273 | 10,909 | 38,182 | (12) |
| Process Plant in Food and Drink Industry | 8,000 | 440 | 400 | 7,160 | 100 | 80,000 | 24,000 | 104,000 | 41,600 | 145,600 | (13) |
| Process Plant in Oil and Gas Production | 550 | 65 | 28 | 458 | 150 | 3,667 | 1,100 | 4,767 | 1,907 | 6,673 | (14) |
| Process Plant in Petroleum Refining | 525 | 70 | 26 | 429 | 150 | 3,500 | 1,050 | 4,550 | 1,820 | 6,370 | (15) |
| Process Plant in Chemicals | 1,500 | 490 | 75 | 935 | 150 | 10,000 | 3,000 | 13,000 | 5,200 | 18,200 | (16) |
| Process Plant in Pharmaceuticals | 1,000 | 300 | 50 | 650 | 100 | 10,000 | 3,000 | 13,000 | 5,200 | 18,200 | (17) |
| Commercial Catering Equipment * | 2,800 | 120 | 560 | 2,120 | 85 | 32,941 | 9,882 | 42,824 | 17,129 | 59,953 | (18) |
| Beer Kegs | 100 | 75 | 2 | 23 | 100 | 1,000 | 300 | 1,300 | 520 | 1,820 | (19) |
| Medical & Dental Instruments and Hospital Equipment | 1,450 | 75 | 290 | 1,085 | 200 | 7,250 | 2,175 | 9,425 | 3,770 | 13,195 | (20) |
| High Precision replication - CD & DVD pressing | 2,600 | 3 | 520 | 2,077 | 130 | 20,000 | 6,000 | 26,000 | 10,400 | 36,400 | (21) |
| High precision replication - electro formed screen printing | 230 | 20 | 46 | 164 | 150 | 1,533 | 460 | 1,993 | 797 | 2,791 | (22) |
| **TOTAL** | **32,255** | **2,308** | **4,547** | **25,400** | | **23,6937** | **84,490** | **321,427** | **128,571** | **449,997** | |

# “End Use” - Analysis of Nickel Used

**Table 11**

| | (1) Total Nickel Volume | (2) Total Nickel Value | Ni vol in Stainless | Ni vol in Alloy | Ni vol in Non-Ferr Ni Based | Ni vol in Non-Ferr Cu Based | Ni vol in Plating | Ni vol in Foundry | Ni vol in Other | (2) Implied Stainless Volume | Implied Alloy Volume | Implied Non-Ferr Ni Based Volume | Implied Non-Ferr Cu Based Volume | Implied Plating Volume | Implied Foundry Volume | Implied Other Volume | Estimated Stainless Value | Estimated Alloy Value | Estimated Non-Ferr Ni Based Value | Estimated Non-Ferr Cu Based Value | Estimated Plating Value | Estimated Foundry Value | Estimated Other Value | Estimated Total Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **000 te** | **Euro M** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **000 te** | **Euro M** | **Euro M** | **Euro M** | **Euro M** | **Euro M** | **Euro M** | **Euro M** | **Euro M** |
| | | | | | | | | | | | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| ***Nickel Dependent Segments*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Automotive Diesel Turbo Chargers | **6.00** | **38.04** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | na | 120.00 | na | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 420.00 | na | **420.00** |
| Aerospace - Jet Engines | **8.60** | **54.52** | 0.30 | 0.30 | 6.00 | 0.10 | 0.30 | 0.90 | 0.70 | 3.33 | 20.00 | 12.00 | 0.67 | na | 18.00 | na | 10.00 | 20.00 | 96.00 | 2.00 | 6.00 | 18.00 | na | **152.00** |
| Gas Turbines | **6.60** | **41.84** | 0.00 | 0.00 | 6.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.20 | 0.00 | na | 0.00 | na | 0.00 | 0.00 | 79.20 | 0.00 | 0.00 | 0.00 | na | **79.20** |
| Process Plant in Food and Drink Industry | **13.60** | **86.22** | 10.80 | 0.90 | 1.70 | 0.00 | 0.00 | 0.10 | 0.10 | 120.00 | 60.00 | 3.40 | 0.00 | na | 2.00 | na | 360.00 | 60.00 | 17.00 | 0.00 | 0.00 | 2.00 | na | **439.00** |
| Process Plant in Oil and Gas Production | **2.30** | **14.58** | 1.10 | 0.20 | 0.50 | 0.00 | 0.00 | 0.50 | 0.00 | 12.22 | 13.33 | 1.00 | 0.00 | na | 10.00 | na | 36.67 | 13.33 | 5.00 | 0.00 | 0.00 | 10.00 | na | **65.00** |
| Process Plant in Petroleum Refining | **2.50** | **15.85** | 1.20 | 0.20 | 0.60 | 0.00 | 0.00 | 0.50 | 0.00 | 13.33 | 13.33 | 1.20 | 0.00 | na | 10.00 | na | 40.00 | 13.33 | 6.0 | 0.00 | 0.00 | 10.00 | na | **69.33** |
| Process Plant in Chemicals | **16.60** | **105.24** | 8.30 | 1.70 | 3.50 | 0.00 | 0.00 | 3.10 | 0.00 | 92.22 | 113.33 | 7.00 | 0.00 | na | 62.00 | na | 276.67 | 113.33 | 35.00 | 0.00 | 0.00 | 62.00 | na | **487.00** |
| Process Plant in Pharmaceuticals | **10.30** | **65.30** | 5.00 | 1.10 | 2.20 | 0.00 | 0.00 | 2.00 | 0.00 | 55.56 | 73.33 | 4.40 | 0.00 | na | 40.00 | na | 166.67 | 73.33 | 22.00 | 0.00 | 0.00 | 40.00 | na | **302.00** |
| Commercial Catering Equipment * | **3.70** | **23.46** | 3.40 | 0.00 | 0.10 | 0.00 | 0.20 | 0.00 | 0.00 | 37.78 | 0.00 | 0.20 | 0.00 | na | 0.00 | na | 113.33 | 0.00 | 1.00 | 0.00 | 4.00 | 0.00 | na | **118.33** |
| Beer Kegs | **3.40** | **21.56** | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 37.78 | 0.00 | 0.00 | 0.00 | na | 0.00 | na | 75.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | na | **75.56** |
| Medical & Dental Instruments and Hospital Equipment | **2.20** | **13.95** | 2.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24.44 | 0.00 | 0.00 | 0.00 | na | 0.00 | na | 73.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | na | **73.33** |
| High Precision replication - CD & DVD pressing | **0.13** | **0.82** | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | na | 0.00 | na | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 | 0.00 | na | **2.60** |
| High precision replication - textile & wallpaper printing | **1.00** | **6.34** | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | na | 0.00 | na | 0.00 | 0.00 | 0.00 | 0.00 | 20.00 | 0.00 | na | **20.00** |
| **TOTAL** | **76.93** | **487.74** | 35.70 | 4.40 | 21.20 | 0.10 | 1.63 | 13.10 | 0.80 | 396.67 | 293.33 | 42.40 | 0.67 | 0.00 | 262.00 | na | 1,152.22 | 293.33 | 261.20 | 2.00 | 32.60 | 562.00 | na | **2303.36** |

## Nickel Value Chain: Salaries & Wages and Employment Taxes

**Table 12.**

| | | | (1) Jobs | (2) Gross Wage Per Person | (3) Total Salaries & Wages Euro M | (4) Taxes Paid by Employee Euro M | (5) Tax paid by Employer Euro M | (6) Total Taxes & Social Charges Euro M |
|---|---|---|---|---|---|---|---|---|
| ***Direct Industry*** | Mining | | 885 | 40,000 | 35 | 11 | 9 | 19 |
| | Smelting/Refining | | 1,700 | 40,000 | 68 | 20 | 17 | 37 |
| | Importation | | 50 | 40,000 | 2 | 1 | 0 | 1 |
| | Trading | | 322 | 40,000 | 13 | 4 | 3 | 7 |
| | Transport | | 595 | 30,000 | 18 | 4 | 4 | 8 |
| | Recycling | | 9,400 | 30,000 | 282 | 62 | 71 | 133 |
| | Multiplier Effect Employment | | 5,181 | 30,000 | 155 | 34 | 39 | 73 |
| | | ***Sub total*** | ***18,132*** | | ***574*** | ***136*** | ***143*** | ***279*** |
| ***First Use*** | Stainless Steel | | 41,600 | 40,000 | 1,664 | 499 | 416 | 915 |
| | Alloy Steels | | 6,760 | 40,000 | 270 | 81 | 68 | 149 |
| | Non Ferrous Alloys - Nickel based | | 3,770 | 40,000 | 151 | 45 | 38 | 83 |
| | Non Ferrous Alloys - Copper based | | 1,040 | 40,000 | 42 | 12 | 10 | 23 |
| | Foundry | | 2,427 | 40,000 | 97 | 29 | 24 | 53 |
| | Plating | | 17,595 | 30,000 | 528 | 116 | 132 | 248 |
| | Intermediaries | | 58,420 | 30,000 | 1,753 | 386 | 438 | 824 |
| | Multiplier Effect Employment | | 52,645 | 30,000 | 1,579 | 347 | 395 | 742 |
| | | ***Sub total*** | ***184,256*** | | ***6,084*** | ***1,516*** | ***1,521*** | ***3,037*** |
| ***End Use*** | Automotive Diesel Turbo Chargers | | 18,750 | 30,000 | 563 | 124 | 141 | 264 |
| | Aerospace - Jet Engines | | 54,545 | 40,000 | 2,182 | 655 | 545 | 1,200 |
| | Gas Turbines | | 27,273 | 40,000 | 1,091 | 327 | 273 | 600 |
| | Process Plant in Food and Drink Industry | | 10,4000 | 30,000 | 3,120 | 686 | 780 | 1,466 |
| | Process Plant in Oil and Gas Production | | 3,900 | 30,000 | 117 | 26 | 29 | 55 |
| | Process Plant in Petroleum Refining | | 4,550 | 30,000 | 137 | 30 | 34 | 64 |
| | Process Plant in Chemicals | | 13,000 | 30,000 | 390 | 86 | 98 | 183 |
| | Process Plant in Pharmaceuticals | | 13,000 | 30,000 | 390 | 86 | 98 | 183 |
| | Commercial Catering Equipment * | | 42,824 | 30,000 | 1,285 | 283 | 321 | 604 |
| | Beer Kegs | | 1,300 | 30,000 | 39 | 9 | 10 | 18 |
| | Medical Instruments etc | | 9,425 | 40,000 | 377 | 113 | 94 | 207 |
| | CD & DVD pressing | | 20,003 | 30,000 | 600 | 132 | 150 | 282 |
| | Textile/wallpaper printing | | 1,993 | 30,000 | 60 | 13 | 15 | 28 |
| | Multiplier Effect Employment | | 126,172 | 30,000 | 3,785 | 833 | 946 | 1,779 |
| | | ***Sub total*** | ***440,735*** | | ***14,134*** | ***3,110*** | ***3,534*** | ***6,643*** |
| | | **TOTAL** | **643,123** | | **20792** | **4,762** | **5,198** | **9,959** |

## Nickel Value Chain: Sales Tax Paid

**Table 13**

| | | | (1) | (2) | (3) |
|---|---|---|---|---|---|
| | | | **Total Sales Value** | **Proportion Liable to Sales Tax** | **Net Sales Tax Paid** |
| | | | **Euro M** | **%** | **Euro M** |
| ***Direct Industry*** | Mining | | 119 | 45 | 11 |
| | Smelting/Refining | | 767 | 45 | 69 |
| | Transport | | 43 | 45 | 4 |
| | Recycling | | 2,870 | 46 | 264 |
| | | ***Sub total*** | | | ***348*** |
| ***First Use*** | Stainless Steel | | 9,600 | 30 | 576 |
| | Alloy Steels | | 1,560 | 30 | 94 |
| | Non Ferrous Alloys - Nickel based | | 870 | 30 | 52 |
| | Non Ferrous Alloys - Copper based | | 240 | 30 | 14 |
| | Foundry | | 560 | 30 | 34 |
| | Plating | | 1,300 | 55 | 143 |
| | Intermediaries | | 4,090 | 65 | 532 |
| | | ***Sub total*** | | | ***1,445*** |
| ***End Use*** | Automotive Diesel Turbo Chargers | | 1,500 | 31 | 93 |
| | Aerospace - Jet Engines | | 8,000 | 25 | 400 |
| | Gas Turbines | | 4,000 | 25 | 200 |
| | Process Plant in Food and Drink Industry | | 8,000 | 30 | 480 |
| | Process Plant in Oil and Gas Production | | 550 | 30 | 33 |
| | Process Plant in Petroleum Refining | | 525 | 30 | 32 |
| | Process Plant in Chemicals | | 1,500 | 30 | 90 |
| | Process Plant in Pharmaceuticals | | 1,000 | 30 | 60 |
| | Commercial Catering Equipment * | | 2,800 | 35 | 196 |
| | Beer Kegs | | 100 | 30 | 6 |
| | Medical & Dental Instruments and Hospital Equipment | | 1,450 | 31 | 90 |
| | High Precision replication - CD & DVD pressing | | 2,600 | 30 | 156 |
| | High precision replication - textile & wallpaper printing | | 230 | 30 | 14 |
| | | ***Sub total*** | | | ***1,849*** |
| | | **TOTAL** | | | **3,641** |

## Nickel Value Chain: Capital Expenditure and Capital Employed

**Table 14**

| | | (1) Total Sales Value Euro M | (2) Investment as % of Sales % | (3) Capital Expenditure Euro M | (4) Fixed Assets Euro M | (5) Net Current Assets Euro M | (6) Total Capital Employed Euro M | (7) Employment Associated With Capital Exp | Multiplier Effect | Total Capex Employment Effect |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Direct Industry*** | Mining | 119 | 5 | 6 | na | na | 137 | | | |
| | Smelting/Refining | 767 | 5 | 38 | na | na | 882 | | | |
| | Transport | 43 | 5 | 2 | na | na | 32 | | | |
| | Recycling | 2,870 | 1 | 29 | na | na | 861 | | | |
| | ***Sub total*** | | | ***75*** | | | ***1,912*** | ***626*** | **250** | **876** |
| ***First Use*** | Stainless Steel | 9,600 | 5 | 480 | na | na | 11,040 | | | |
| | Alloy Steels | 1,560 | 5 | 78 | na | na | 1,794 | | | |
| | Non Ferrous Alloys – Nickel based | 8,70 | 5 | 44 | na | na | 1,001 | | | |
| | Non Ferrous Alloys - Copper based | 240 | 5 | 12 | na | na | 276 | | | |
| | Foundry | 560 | 5 | 28 | na | na | 644 | | | |
| | Plating | 1,300 | 4 | 52 | na | na | 910 | | | |
| | Intermediaries | 13,633 | 2 | 273 | na | na | 3,408 | | | |
| | ***Sub total*** | | | ***966*** | | | ***19,073*** | ***8,051*** | **3,221** | **11,272** |
| ***End Use*** | Automotive Diesel Turbo Chargers | 1,500 | 5 | 75 | 750 | 375 | 1,125 | | | |
| | Aerospace - Jet Engines | 8,000 | 5 | 400 | 4000 | 2000 | 6,000 | | | |
| | Gas Turbines | 4,000 | 5 | 200 | 2000 | 1000 | 3,000 | | | |
| | Process Plant in Food and Drink Industry | 8,000 | 5 | 400 | 4000 | 2000 | 6,000 | | | |
| | Process Plant in Oil and Gas Production | 550 | 5 | 28 | 275 | 138 | 413 | | | |
| | Process Plant in Petroleum Refining | 525 | 5 | 26 | 263 | 131 | 394 | | | |
| | Process Plant in Chemicals | 1,500 | 5 | 75 | 750 | 375 | 1,125 | | | |
| | Process Plant in Pharmaceuticals | 1,000 | 5 | 50 | 500 | 250 | 750 | | | |
| | Commercial Catering Equipment * | 2,800 | 3.5 | 98 | 980 | 490 | 1,470 | | | |
| | Beer Kegs | 100 | 4 | 4 | 40 | 20 | 60 | | | |
| | Medical Instruments etc | 1,450 | 5 | 73 | 725 | 363 | 1,088 | | | |
| | CD & DVD pressing | 2,600 | 4 | 104 | 1,040 | 520 | 1,560 | | | |
| | Textile/wallpaper printing | 230 | 5 | 12 | 115 | 58 | 173 | | | |
| | ***Sub total*** | | | ***1,544*** | ***15,438*** | ***7,719*** | ***23,156*** | ***12,865*** | **5146** | **18,010** |
| | **TOTAL** | | | **2,585** | | | **44,141** | **21,542** | **8,617** | **30,159** |

## Nickel Value Chain: R&D Expenditure

**Table 15**

| | | (1)<br>**Total Sales Value**<br>**Euro M** | (2)<br>**Expenditure on R&D as % of Sales**<br>**%** | (3)<br>**Estimated Expenditure on R&D**<br>**Euro M** |
|---|---|---|---|---|
| ***Direct Industry*** | Mining | 119 | 1 | 1 |
| | Smelting/Refining | 767 | 1 | 8 |
| | Transport | 43 | 0 | 0 |
| | Recycling | 2,870 | 0.5 | 14 |
| | ***Sub total*** | | | ***23*** |
| ***First Use*** | Stainless Steel | 9,600 | 1.5 | 144 |
| | Alloy Steels | 1,560 | 1.5 | 23 |
| | Non Ferrous Alloys - Nickel based | 870 | 1.5 | 13 |
| | Non Ferrous Alloys - Copper based | 240 | 1.5 | 4 |
| | Foundry | 560 | 1.5 | 8 |
| | Plating | 1,300 | 1 | 13 |
| | Intermediaries | 4,090 | 0 | 0 |
| | ***Sub total*** | | | ***205*** |
| ***End Use*** | Automotive Diesel Turbo Chargers | 1,500 | 3.5 | 53 |
| | Aerospace - Jet Engines | 8,000 | 12 | 960 |
| | Gas Turbines | 4,000 | 12 | 480 |
| | Process Plant in Food and Drink Industry | 8,000 | 1 | 80 |
| | Process Plant in Oil and Gas Production | 550 | 1 | 6 |
| | Process Plant in Petroleum Refining | 525 | 1 | 5 |
| | Process Plant in Chemicals | 1,500 | 1 | 15 |
| | Process Plant in Pharmaceuticals | 1,000 | 1 | 10 |
| | Commercial Catering Equipment * | 2,800 | 2 | 56 |
| | Beer Kegs | 100 | 1 | 1 |
| | Medical & Dental Instruments and Hospital Equipment | 1,450 | 5 | 73 |
| | High Precision replication - CD & DVD pressing | 2,600 | 3 | 78 |
| | High precision replication - textile & wallpaper printing | 230 | 3 | 7 |
| | ***Sub total*** | | | ***1,823*** |
| | **TOTAL** | | | **2,051** |

| | |
|---|---|
| Filename: | SocioEconomicImpactNickel-29Jan04-FinalReport-logo.doc |
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