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# **Research and Development about Metallurgical Industry of Romania**

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Additional information is available at the end of the chapter

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## **Abstract**

Our chapter wishes to be a critical and reasoned radiography of the evolution/involution of metallurgical industry in Romania during the period 1990–2016. The importance of metallurgical industry, for any state, is obvious and overwhelming. In this context, paraphrasing a known dictum, we can strongly say that in the industrial environment and in life generally ‘if there is no metallurgy, nothing is!’ The structure and content of our material is logical one and evolutionary. So, we firstly present in order a description of the main metallurgical companies in Romania (companies in the steelmaking industry: COS Mechel Targoviste, ArcelorMittal Galati; companies from non-ferrous metallurgy: Alro Slatina, CupruMin Abrud; metallurgical companies in the manufacturing and assembly industry: Metalurgica Aiud, Timken S.A Ploiesti). In Section 3, we describe critical components concerning the involution of steel industry in Romania. Thus, we analyse: benchmarks, restructuring of the steel industry in Romania, the impact of the global crisis on the steel sector in Romania, privatization, modernization/restructuring and monitoring between 2004 and 2008. In Section 4, we present the prospects of metallurgical industry in Romania, and in Section 5, we present technical-economic components specific to the industry of metal materials.

**Keywords:** metallurgical industry, research, development, restructuring, privatization

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## **1. Introduction**

Metallurgy is a branch of industry which includes the processes for obtaining metals from ores and from other raw materials and resources. Metallurgy includes the processing of ores, extraction of metals from ores, refining of metals, production of metal alloys, metal processing under pressure, manufacture of cast metal parts, thermal, thermochemical, thermomechanical

processing, welding and soldering metals and alloys, surface coating of the metal parts with a layer of other metals by diffusion of certain substances (metallic or non-metallic) in the superficial layer of metal objects [1–3].

Metallurgy has existed since ancient times. The evolution and technological progress of metallurgy have generated and secured the general progress of humanity. Paraphrasing a known adage, 'if there is no metallurgy, nothing is!'

Global steel industry is facing an overcapacity in production of over 700 million t, and the government of the states which produce steel is looking for solutions to keep the companies and their employees under the circumstances in which the consumption is declining [5–8].

Also, the dumping price to which is delivered the steel produced in China makes the representatives of the European steel industry to ask for trade protection measures when faced to the assault given by the competition from outside the community block [4, 9, 11].

Romanian metallurgy, unfortunately, after 1989 has suffered a quasi-total setback. The decline and involution of Romanian metallurgy has multiple causes, among which we mention: very high specific consumptions (both energy, and of materials), significant reduction of the sale markets, replacement of domestic capital with the foreign and fraudulent privatizations [10, 12, 13].

## 2. Description of the main metallurgical companies in Romania

### 2.1. Companies in the steel industry

Targoviste Special Steel Compound (formerly Mechel Targoviste) is a company in the steel industry in Romania, owned by the Nikarom Invest company in Bucharest. Targoviste Special Steel Compound (**Figure 1**) was privatized in 2002; it was taken over by the Conares Trading company, registered in Switzerland. The transaction value was about 35 million dollars. Conares later became part of the Russian group Mechel.

In February 2013, Mechel sold all its properties in Romania, including the plant in Targoviste, for the symbolic sum of 230 Lei to the Invest Nikarom company from Bucharest and Mechel Targoviste returned to the old name of Special Steel Compound Targoviste.

In 2013, the company consumed about 0.4 TWh of energy, nearly 1% of the total energy consumption of Romania [14, 15].

Since 1978, from its opening, Special Steels Compound Targoviste was equipped with modern technology for the production of special- and high-alloyed steels necessary for the development of national, civil and defence industry (e.g. most of the steel used in the construction of the nuclear power plant in Cernavoda was developed in Targoviste).

In Targoviste plant, the forged blocks and bars (FBB) department was created and it was equipped with a capital infusion of over \$90 million in quotation of the 1980s, and with radial



**Figure 1.** Special Steels Compound Targoviste.

forging machines of the latest generation [In 2010, the department owned only the FBB equipment in Southeast Europe which is having NATO certificates.

Number of employees in 2013: 2000

- Fiscal value
  - 2013: 430.5 million Lei (97.7 million Euros)
  - 2010: 851.7 million Lei (202.3 million Euros)
  - 2009: 529.6 million Lei
  - 2006: 646.8 million Lei (231 million dollars)
- Net income
  - 2010: 155.1 million Lei (36.8 million Euros)
  - 2009: 100 million Lei
  - 2006: 8.9 million Lei (3.2 million dollars)
  - 2005: 56.8 million Lei

Losses for the years 2005, 2009 and especially 2010 should be noted. Thus, according to [www.wall.stret](http://www.wall.stret), in 2010, the fiscal value of the steel plant Mechel Targoviste (COS) increased by 61% to 851.7 million Lei (202.3 million Euros), but the company had losses for the second consecutive year, according to preliminary financial results forwarded by Bombay Stock Exchange (BSE).

The Special Steels Plant (COS), the largest employer in Targoviste, which is struggling to survive insolvency from the beginning of the year, is strongly affected by the export of scrap mainly in Turkey, which keeps the price of the main raw material with an average of about 80% of production costs at a high level and reduces the competitiveness of the plant for export.

As long as we export scrap, it is an advantage for the Turks to bring us steel-concrete because they succeed to do the so-called full on full transport. It is interesting to see if Germany or France exports scrap. One realizes that they also collect scrap metal, 'It is about what tax and policies we apply'. In the first half of the year, COS Targoviste business was reduced three times from 481 to 136.2 million Lei (31 million Euros) and the local production of steel-concrete collapsed in the same period by 76% to 44,000 t. On the other hand, imports of steel-reinforced concrete rose between 2010 and 2012 by 17% to 324,000 t.

A compound/plant cannot be closed and opened as if it was a shop door. One needs to find solutions so that it works all the time, even when it does not have enough orders because it has large expenditures even when not producing anything. If an electric arc furnace (EAF) is stopped, its durability (refractories and other components) drops to repeated restarts.

The new shareholder with the trustees is trying to recover the company going through insolvency since February this year after several wrong decisions taken by Russian management from Mechel, such as export of concrete steel with increased costs that led the plant to face loss after loss. After this strategy failed, Mechel cut off the funding of Targoviste plant and sold it for nothing in order to escape the loss of tens of millions that hung heavily in the balance sheet of the group.

From November last year until March, the production of The Special Steels Targoviste (formerly Mechel Targoviste) was completely stopped and its employees had lost hope of ever returning to work.

The consequences of these closures have been worst for the Romanian economy and turned the steel-concrete domestic market upside-down. For example, the closure of the Mechel enterprise led, in the first half of the year, to a fall of the concrete steel production in Romania by 76% to 44,000 t.

The COS Targoviste business fell in the same period of time by 3.5 times, from 481 to 136.2 million Lei (31 million Euros), while the compound has been mainly closed. The losses of this plant were reduced in the same period from 59.5 to 19.3 million Lei.

The Mechel production cuts have also led to import steel-reinforced concrete to invade the Romanian market, reaching up to 17% in the last 2 years, while last year they reached to 324,000 t, more than half of our internal needs. This is happening while the actual production capacity of COS Targoviste could cover the entire consumption of steel-concrete in Romania, which contracted sharply in recent years, currently reaching 550,000–600,000 t.

After the takeover by Nikarom Invest, a company controlled by Svetlana Chumakova and Victor Chumakova, the parents of Olga Chumakova, former head of Mechel representative in Bucharest, the company became insolvent on its own request/initiative and the entire



production flow was redesigned so that the plant would manage on its own without any financial help from outside.

The new shareholder from COS Targoviste took harsh restructuring measures, which focused on the reduction of employees and merging the production departments in order to minimize costs in the context of having lost orders from traditional customers because of inactivity.

However, the management has taken steps to reintroduce special steels with higher added value into production; they made minimal investment in new compressors to reduce energetic costs and geared towards technological processes, such as heat treatment, to obtain steels in order to reduce the cost to a minimum, while increasing market competitiveness.

An entire city depends on the outcomes of these reorganizations, a city that, in the last two decades, was devastated by deindustrialization and loss of jobs from this large plant.

In the last decade, Targoviste, a city that relies on three steel companies on the industrial platform from COS Targoviste, has lost about 16,000 inhabitants, or 17.8% of the total between 2002 and 2012. During this time, more than 4000 people who were working at the Mechel steel large plant Targoviste have lost their jobs. There were 6160 employees in 1999, and only 2100 employees last year.

The plant currently has about 1370 employees, layoffs taking place a few months ago when 530 people left the company. Even so, COS Targoviste remains the largest employer in the city of Targoviste, and on the same industrial platform there are two more companies supporting the city employment, namely Steellinox controlled by the South Koreans from Samsung, which has 840 employees, and Erdemir with Turkish shareholders, which employs about 340 people.

Before 1989, the large plant had 5500 employees. There were 11 electric arc furnaces for steelmaking. The plant capacity was about the same but it used another kind of metallurgy. The furnaces were far smaller and while a batch takes 60 minutes these days, in the old furnaces it took about 3–4 hours. Now there is one oven modernized furnace with three oxy-fuel burners that can sustain a continuous production of 500,000 t/year.

Although before 1989 Romania was a closed, low performance economy, the plant in Targoviste managed to export to countries such as Syria, Iraq and CAER region (USSR, East Germany, Bulgaria, Poland, Czech-Slovakia, Hungary).

Restricting the plant activity only in the local market, 60% from exports as it had in 2011 eliminated, has hit jobs in the factory. After recent restructuring, tasks were redistributed so that two people can now do what three people used to do years ago.

One of the major problems the plant is facing is that exports of scrap, particularly in Turkey, keep the scrap price at a high level, increasing the costs of steel produced internally.

Besides imports, the plants are facing new competition from the Italians from STG Group, which reopened the mill production in Focsani last year and compete in the segment of reinforced concrete.

To increase efficiency, the plant in Targoviste has launched the so-called special steels into production this month; these are types of steel with higher added value than the steel-concrete, trying to gradually recover the market. In the first month 2500 t of special steel will be produced, less than 10% of the capacity of the mill, while the old customers have shifted to other suppliers when the plant was closed, and now they are purchasing smaller quantities from the plant in Targoviste.

The plant lost one of the most important customers in the domestic market, Dacia Pitesti, shortly after Dacia has been taken over by the French from Renault, who has abandoned forges and other equipment of steel processing supplied by Targoviste plant to produce the car parts, and now car parts are imported from Turkey or France.

The production facilities now in industrial heath on the platform in Targoviste testify to the impressive growth that the steel industry had taken here before 1989. Shortly after they have taken over the plant in August 2002, the Russians from the Mechel group closed the Steelworks number one and the departments responsible for steel processing and have not been reopened them so far.

The Steelworks closed in 2004 produced stainless steel and high alloy steels such as those for the food industry (cooking pans, cutlery, etc.) and for the medical industry, mainly medical instruments requiring more special steels. Between 1980 and 1986, the steelworks produced special steels for the nuclear program, respectively, the nuclear power plant in Cernavoda.

The Russians have motivated the closure of these compounds through lack of demand and outdated technology which did not allow competing with exports from neighbouring countries, such as Germany. Currently most of the market is covered by imports from Germany.

COS Targoviste business is decreased by 3.5 times in the first semester, from 481 to 136.2 million Lei (31 million Euros)

- Losses in Targoviste plant decreased in the first half of the year by three times to 19.5 million Lei (4.4 million Euros).
- Romania's production of steel-concrete decreased by 76% from 180,000 to 44,000 t in the first semester.
- Romania's imports of steel-concrete increased by 17% to 324,000 t, during 2010–2012.
- The number of employees at COS Targoviste decreased from 5500 before 1989 to 1370 employees these days.
- The price of a tonne of special steel reaches 690 Euros, compared to 490 Euro/t for concrete steel.
- An employee of COS Targoviste earns an average salary of 1500–1600 Lei in total including bonuses and other benefits.
- One tonne of steel-concrete used to cost about 3100 Lei in 2007 and now it is a little above 2000 Lei.

### 2.1.1. ArcelorMittal Galati

ArcelorMittal Galati, the largest steel mill in Romania (which currently has around 6000 employees) will suppress about 1500 jobs by 2020 by natural wastages, but will hire around 100 young workers annually came from the schools of apprentices.

Since 2009 until now, the company of Indian billionaire Lakshmi Mittal has invested in Galati over 350 million Euros. A part of the financial losses is found in the modernizations made to the unit and financed by the group.

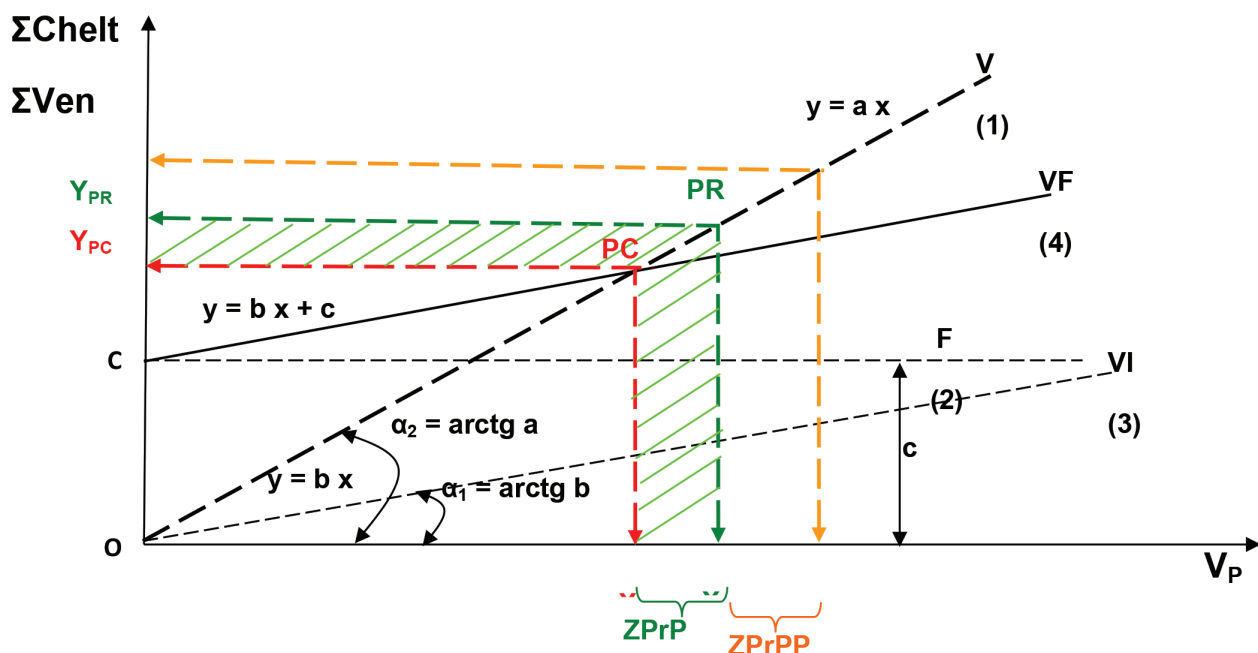
Another major investment, inaugurated at the beginning of the year, at the heavy plate mill is the hot leveller for flawless surface, which ensures that the plate is flat, a project that costs 14 million Euros.

The company is planning to maintain an annual investment budget of over 25 million Euros.

At the same time, the parent company has set a target of the achievement in 2017 of the break-even point (profitability threshold): the level at which the revenue shall be equal to the expenses and the company has no profit or loss. In **Figure 2**, the diagram of the break-even method is introduced.

ArcelorMittal Galati, former Sidex Steel Mill, was bought from the state in 2001 with 70 million Euros by Indian billionaire Lakshmi Mittal, who has assumed the commitment to invest 350 million Euros.

The largest steel producer in the world has stated that at the capital increase is to be added 1 billion dollars from the sale of a 35% participation of Gestamp shares, Spanish company



**Figure 2.** Graphical representation of the break-even method ZPrP: Expected profit area; ZPrPP: Up expected profit area.



specialized in the production of steel for the automotive industry. The Mittal family, which at the end of last year had 39.4% of the shares in the steel mill, will take part in the capital increase with 1.1 billion dollars.

This capital increase combined with the sale of the minority participation in Gestamp will accelerate the company's plans aiming at reducing the debt and will allow us to decrease the net debt at less than 12 billion dollars. This will ensure that the business will remain resilient in any context of the market and places ArcelorMittal in a position of power from which we can further improve our performance.

In parallel, ArcelorMittal has announced that in 2015 its operating profit has declined by 28% up to 5.2 billion dollars while sales were reduced by 19% to 31.9 billion dollars. The year 2015 was a very difficult year for the steel and mining industries. Although the demand on our main markets has remained strong, prices have been significantly reduced in the last year as a result of excess capacity from China.

Two years ago, ArcelorMittal has revised on two occasions the profit estimates in the conditions under which the Chinese exports have led to lower prices for steel in Europe and the USA, the main markets of the ArcelorMittal Group. In 2015, steel exports from China have increased by a fifth up to the record value of 112 million t, so that in November the prices for steel in Europe have reached the lowest level after 2007, with 75% below the maximum level.

In these circumstances, ArcelorMittal will launch a new 5-year plan, hereinafter called the 'Action 2020', intended to improve the results on the five operational segments and will return to an operating profit of over 85 dollars/t, under the conditions in which the last year has dropped up to 62 dollars/t.

ArcelorMittal is the largest steel and mining company in the world, present in more than 60 countries, in 19 of them with their own production units. In Romania, ArcelorMittal owns production units in Galati, Iasi, Roman and Hunedoara.

The company reported a loss of 6 billion dollars in the fourth quarter, which raised the negative result for the entire year passed to 7.95 billion dollars. During the last 3 months of 2014, ArcelorMittal recorded a loss of 711 million dollars, while per the full year registered a loss of 1.1 billion dollars.

The massive loss in the fourth quarter of last year also includes revaluation of assets of 4.8 billion dollars related to the operations of iron ore production.

## 2.2. Companies in the nonferrous metallurgy

**Alro Slatina**, the largest aluminium producer in Central and Eastern Europe, has recorded in 2015 a preliminary adjusted net income of 85 million Lei (19.1 million Euros), compared to a loss of 134 million Lei registered in 2014, having business growing by 15% of 2.3 billion Lei.

The Company S.C. Alro Slatina S.A. was established by the Romanian Government in March 1963, by building the first and the only Romanian aluminium plant in Romania, more precisely in Slatina, Olt County. In **Figure 3**, the registered office of this company is shown.



**Figure 3.** Registered office and corporate headquarters of the company ALRO S.A. Slatina.

Alro ('the parent company' or the 'Company' or 'Alro') company established in March 1963 (under the name of 'Uzina de Aluminiu', 'Aluminium Plant') and organized under the Romanian legislation, is part of an Integrated Aluminium Production Group, covering the whole technological chain from bauxite up to obtaining processed products.

**Vimetco N.V.:** The Netherlands is the majority shareholder in Alro S.A., holding at present 84.19% of the company's shares. Vimetco N.V. is a private capital company which carries out business in Romania, China and Sierra Leone and is listed on the Stock Exchange in London. Alro Group comprises the following companies: Alro—manufacturer of aluminium (company listed at the Bucharest Stock Exchange), Alum—manufacturer of alumina (company listed at the Bucharest Stock Exchange), SMHL—manufacturer of bauxite, Vimetco.

Aluminium production has started in 1966 with a capacity of 50,000 t of aluminium per year.

By 1989, the production capacity went up to 263,000 t/year.

Because of the difficult economic conditions in Romania, in 1990–1991, production decreased to 110,000 t/year, subsequently increasing gradually up to 170,000 t.

In 1996, Alro was transformed into a joint stock company and, in October 1997, a 49% stake of the shares was listed on the Bucharest Stock Exchange, so that the government had the majority stake of shares (51%).

In 2002, the Romanian state has sold for an amount of 11.5 million dollars, six packages of 10% of Alro's shares to the investor Marco Group, which already owned (directly and indirectly) 41.85%, the latter thus becoming the majority shareholder.

In 2006, Alro merges with Alprom Slatina and Alum Tulcea. In April 2007, Marco Group changes its name into Vimetco. At present, Vimetco N.V. owns over 87% of the shares in Alro. Since Alro's privatization in 2002, Marco Group has invested in the company over 210 million USD, which have enabled the improvement of environment protection, as well as the increase by 20% of production (at 184,000 t), compared to the period prior to privatization.

The operating profit (earnings before interest, taxes and amortization (EBITA)) registered in 2015 went up to 198 million Lei, six times higher than in 2014. The net profit of the company was 9.6 million Lei in 2015, compared to a loss of 109 million Lei registered in 2014.

The investment of over 550 million dollars made in the past 11 years has helped Alro to consolidate and to extend its product portfolio to reduce its specific power consumption and final costs. Moreover, the reduction in the support scheme for the renewable energy sector has the role to eliminate distortions faced by the non-ferrous metallurgical industry.

The results are also due to the programs for increasing production capacity for the products with high added value, as well as for increasing the operational efficiency and for reducing energy dependence.

Thus, the cost of raw materials has declined also due to operation of the recycling waste aluminium capacity. About 10% of the primary aluminium produced in Alro originates from recycled waste. For this type of aluminium, electricity consumption is by 90% lower as compared to the one for producing electrolytic aluminium.

In 2015, total production of primary aluminium was of 271,000 t, growing from 263,000 t, registered in 2014. The production of processed aluminium was close to 79,000 t, compared to almost 78,000 t in 2014.

The company has secured in 2015 the amounts needed for investments, signing in December a loan facility with the Black Sea Trade and Development Bank, worth 60 million dollars, with a maturity of 7 years, out of which 15 million dollars have already been invested in the company during 2015.

At the same time, Alro has signed in December a revolving loan of 137 million dollars with a consortium of banks, with maturity in December 2017, which refinances, mainly, a loan from the European Bank for Reconstruction and Development, worth 120 million dollars, obtained in 2010.

The aluminium manufacturer signed in December the extension until December 2017 of another revolving loan of 180 million Lei, concluded with a commercial bank in December 2013. At December 31, 2015, the company had the whole facility of 180 million Lei used for the working capital.

The company's shares are held by Vimetco (Netherlands) at the rate of 84.2% and the Property Fund controls 10.2% of the titles, according to the data at the end of 2015.

**CupruMin Abrud** is a company in Romania whose main objective of activity is the extraction of non-ferrous metal ores. The main activity of CupruMin is the extraction and processing of copper ore from Rosia Poieni mine, selling the copper concentrate and precious metals, which is at present under concession to other companies: Energo Mineral, Cuprom and Ipronef.



In 2008, the company carries out only the secondary activities, namely: extraction of andesite and limestone for construction, shooting, transport of goods and people. The company does not own mining objectives the closing of which has been approved by the government decision.

The company has been launched for privatization in May 28, 2008, at the starting price of 25 million Euros, but the process was interrupted after pre-consultation with European officials, according to whom the planned privatization does not comply with the rules on state aid. The second attempt for privatization was carried out in November 2008, at the starting price of 27 million Euros. In December 2008, the attempt of privatization was cancelled due to the unfavourable economic situation.

In November 2009, after more than a year of inactivity, the activity has been restarted. In March 2010, CupruMin had 420 employees and produced 400 t of copper ores per month.

The copper deposit at Rosia Poieni is estimated at 900,000 t (60% of Romania's copper reserves) which allows the continuation of exploitation for a period of at least 20 years.

In **Figure 4**, the processing plant of copper ores within CupruMin Abrud is shown.

In March 2012, the company Roman Copper Corp. Canada has been declared the winner of the tendering procedure for taking over the whole capital of CupruMin, owned by the Ministry of Economy.

CupruMin Abrud reduced the number of employees from 930 in 2005 to 500 in 2014, hence with approximately 47%.



**Figure 4.** The processing plant of ores within CupruMin Abrud.

## 2.3. Metallurgical companies in the field of processing and assembly

### 2.3.1. *Metalurgica Aiud*

The existence within the city of Aiud since the eighteenth century of a tradition in the production of steelwork and carpentry organized in guilds, led to the formation of a factory of building materials and steelwork in 1894, from which the current metallurgical enterprise has developed.

Since 1931 has turned in the factory of technical articles 'GENIUS', with headquarters in Brasov and since 1933 is registered in Aiud the existence of the 'Technical Laboratory Eng. A.I. Stoica', which besides the items for pressing and manufacturing metal packaging, produces also items for equipping the army.

Beginning with 1948, the enterprise was reorganized and has operated under the name of 'Uzina Rapid Aiud' and has had as manufacturing profile: pumps and appliances for the extinction of fires, steelwork items, metal wheelbarrows, simple agricultural machinery and consumer goods cast from cast iron.

Since 1951, the enterprise has been transferred as workshop for the maintenance and repair of rolling stock under the authority of 'Combinatul Siderurgic Hunedoara' (currently ArcelorMittal Hunedoara), changing their manufacturing profile into the repair of locomotives, repair services of wagons, casting cars and mine-cars.

As a result, at the end of 1954, the enterprise became a unit with economic management of its own under the name of 'Întreprinderea Metalurgică Aiud' ('Metallurgical Enterprise Aiud') having a manufacturing profile of the repair of rolling stock on the entire sector of steel industry. Beginning with 1958, the enterprise focuses on the manufacture of metal constructions, machinery and spare parts for the steel industry, metallurgy and machine building industries.

In **Figure 5**, the access gate within the enterprise Metalurgica Aiud is shown.

Investments during 1966–1970 have been channelled mainly for the development of the hot sector, of centrifugal casting in particular of metal constructions and technological equipment.



**Figure 5.** Access within the enterprise Metalurgica Aiud.



1970–1980 is the period in which the enterprise benefits from other two stages of development which have the effect of extending the existing production capacities, of increasing the level of integration, being assimilated new products with a high technical level. It is the period when the enterprise was considered to be the ‘Chief Mechanic’ of Romanian metallurgy and steel industry.

In December 2006, S.C. Metalurgica S.A. Aiud has sold its assets and stock-in-trade to the company S.C. Remarul 16 Februarie S.A. Cluj-Napoca, a company with 100% private capital. Thus was founded ‘Remarul Metalurgica Aiud’ as a working point of S.C. Remarul 16 Februarie S.A.

‘Remarul Metalurgica Aiud’ is an integrated company, having primary sectors that provide static or centrifugal castings, forged, mecano-welded unfinished goods and sectors of thermal treatments and mechanical processes.

With effect from April 15, 2008, the company bears the name of ‘Metalurgica Transilvană Aiud’. This represents also the date of a new start in respect of the company’s image. In **Figure 6**, aspects of the technological processes carried out in Metalurgica Aiud are shown.

Metalurgica Aiud was a company specialized on the production of machinery for metallurgy and metal constructions in Romania. It is the only producer in Romania for a range of products such as radiant tubes for heat treatment furnaces with controlled atmosphere, cast iron rollers, etc.

In June 30, 2005, the ‘Serviciile Comerciale Române’ (Romanian Commercial Services) through ‘Contactoare Buzău’, together with the businessman of Russian origin, Victor Ianusco and with Metalurgica’s Employees Association, took over through AVAS the package of almost 74.5% of the share capital, for the amount of 5.3 million Euros. The business has proved to be a failure, whereas the consortium has not complied with the privatization contract, by not paying the shares.

In December 2006, the company has sold most of the assets to the company in the rail industry Remarul 16 Februarie for 3 million Euros. Remarul 16 Februarie took over also the employees of Metalurgica Aiud.

On March 13, 2013, the Court of Aiud decided officially the entry into bankruptcy of the company Metalurgica Aiud, after the company has not registered profit since 2008 and at the level of March, 2013 had over 6 million Euros in debts. The activity was stopped and the goods were put on sale.

Involution of the number of employees of S.C. Metalurgica Aiud was the following:

- 2003: 1200
- 2004: 1050
- 2005: 800
- 2010: 480
- 2010: 272
- 2013: 170



**Figure 6.** Technological processes carried out within S.C. Metalurgica Aiud.

### 2.3.2. *Timken S.A. Ploiesti*

Timken has 63 production facilities and service centres throughout the world, including eight production facilities in Europe located in Italy, France, Poland, Romania and Great Britain.

Timken has registered sales in worth of 3.1 billion dollars in 2014.

The American Group Timken will invest 237 million Lei (about 54 million Euros) in the manufacture of components for the automotive industry which they want to build next to Ploiesti, in Aricești Rahtivani, project for which they have received a state aid of 66 million Lei (15 million Euros).

Timken announced about 2 weeks ago that they would build next to Ploiesti, the second factory on the Romanian market, where they will produce tapered roller bearings for the global network of the group. Building of the unit with an area of 15,000 m<sup>2</sup> will start in the first quarter of 2016 and production is estimated to start in 2017.

In **Figure 7**, images with the location of Timken company in Romania are shown.

According to data published by the Ministry of Public Finance, the factory near Ploiesti will produce bearings, gears, gearboxes and mechanical components of the driveshaft. The state aid has been approved in November.

In **Figure 8**, examples of products of Timken S.A., Ploiesti, Romania are shown.

Timken started its activity on the Romanian market in 1997, when they took over from the state approximately 70% of the shares of the company Rulmenți Grei Ploiesti, within a transaction of about 40 million dollars.



**Figure 7.** Images with the location of Timken company in Romania.

The new factory consolidates the group's presence in Europe. The investment supports the company's plan of strategic growth, DeltaX, that aims at geographical expansion, increasing competitiveness and acceleration of development and marketing activities of the products.

The American group develops, manufactures and sells bearings, transmission systems, engines, gearboxes, chains and related products, offering a wide range of services for the reconstruction of propulsion and repair systems. Timken owns 63 factories and service centres in 28 countries and has 14,000 employees.





**Figure 8.** Products of the company Timken S.A. Ploiesti, Romania.

Timken sales decreased by 10% to 707.4 million dollars in 2015, mainly due to the fluctuations in exchange rates and to the decreasing demand on the global market. In 2014, the Group reported sales of 3.1 billion dollars.

### 3. Evolution of the steel industry in Romania

#### 3.1. Benchmarks

- Creation of the legislative framework for implementing the principles of market economy and initiation of the process of decentralization of the state economy (since 1990).
- Ratification, by Law 20/1993 of the Association Agreement of Romania to the EU and adjacent to that of the Protocol 2 ECSC;
  - i. Establishing the Contact Group ECSC Romania, EU.
  - ii. Initiating full trade liberalization program.
  - iii. Initiating the complex process of restructuring the Romanian steel sector.
  - iv. Romania becomes for the first time, through the steel sector, Observer of the Steel Committee within the OECD (1993).
- Completion the privatization process of all existing integrated steel mills and manufacturing companies, with strategic investors: ArcelorMittal, Tenaris, Mechel, TMK, Samsung, Erdemir, etc. (2004).
- Adoption of a plan for restructuring of the steel sector in accordance with the requirements of the European Union and its implementation (GD No 213/2002).

#### 3.2. Restructuring of the steel industry in Romania

- Drafting, approval by the Government of the 'Strategy for Restructuring the Steel Industry in Romania and of the Viability Individual Plans of Steel Companies for the Period

2003–2008 (GD no.55 from January 2005) and validation thereof by the European Commission in the context of closing Chapter 6: Competition.

- Signing of the Treaty of Ascension to the EU within which under Annex VII are comprised:
  - Basic principles of the restructuring process of the steel sector.
  - Interface elements of government: steel companies.
  - Commitments taken in order to make viable in economic-financial terms until 2008 all companies in the steel industry.
  - Monitoring of the restructuring process; drafting by the Economy and Trade Ministry of the biennial reports and sending them to the European Commission.
- Obtaining the status of Full Participant of the Steel Committee within the Organization for Economic Cooperation and Development (October 2005).
- Carrying out of the restructuring process in the steel companies in accordance with the provisions of the strategic documents on the favourable background of steel demand on the market (2005–2008).
- Results of the restructuring process monitoring
  - The companies restructured ArcelorMittal Galati, ArcelorMittal Hunedoara, COS Targoviste, Industria Sârmei Câmpia Turzii, TMK Resita and Tenaris Calarasi represented in 2008 a percentage of over 90% of the domestic production of crude steel.
  - The state aid amounting to 1.52 billion Euros was targeted first on the financial restructuring (the conversion of debts into capital, prescription of debts for the utility suppliers) and to a lesser extent for the tax exemptions (VAT tax and the corporate profit).
  - After 2004, the state aid has not been granted and paid anymore, neither to the companies mentioned nor to any other steel producer in Romania.
  - The production capacities of steel, the lamination capacities, the number of employees in the steel industry has been reduced.

In **Figure 9**, the involution of production capacities and, in **Figure 10**, the involution of the number of employees in the steel industry of Romania, are shown.

We note drastic reduction of production capacities in 2003 as follows:

- By 46.3% for steel making capacities (from 17,505 t in 1993 to 9400 in 2003).
- By 60.8% for semi-finished products capacities (from 15,125 t in 1993 to 5925 in 2003).
- By 10.9% for hot rolled finished products capacities (from 11,250 t in 1993 to 10,020 in 2003).

We see drastic reduction of the number of personnel, as follows:

- By 58.2%, from 143,615 in 1993 to 60,000 in 2003.
- By 45.4%, from 60,000 in 2003 to 32,788 in 2008.



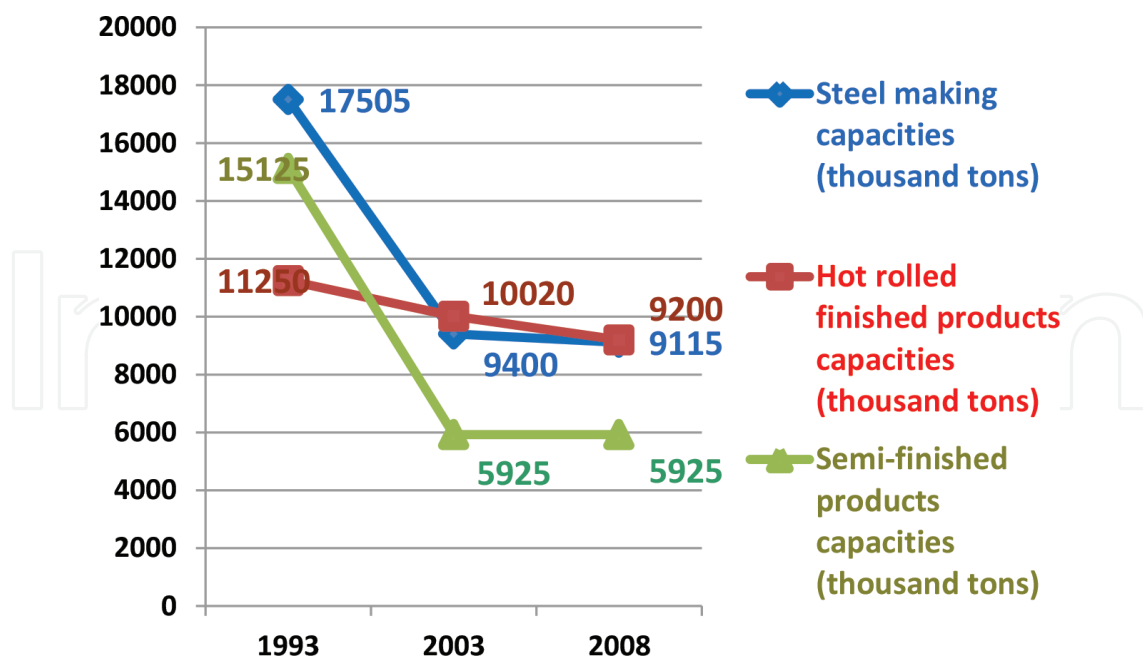


Figure 9. Involution of production capacities.

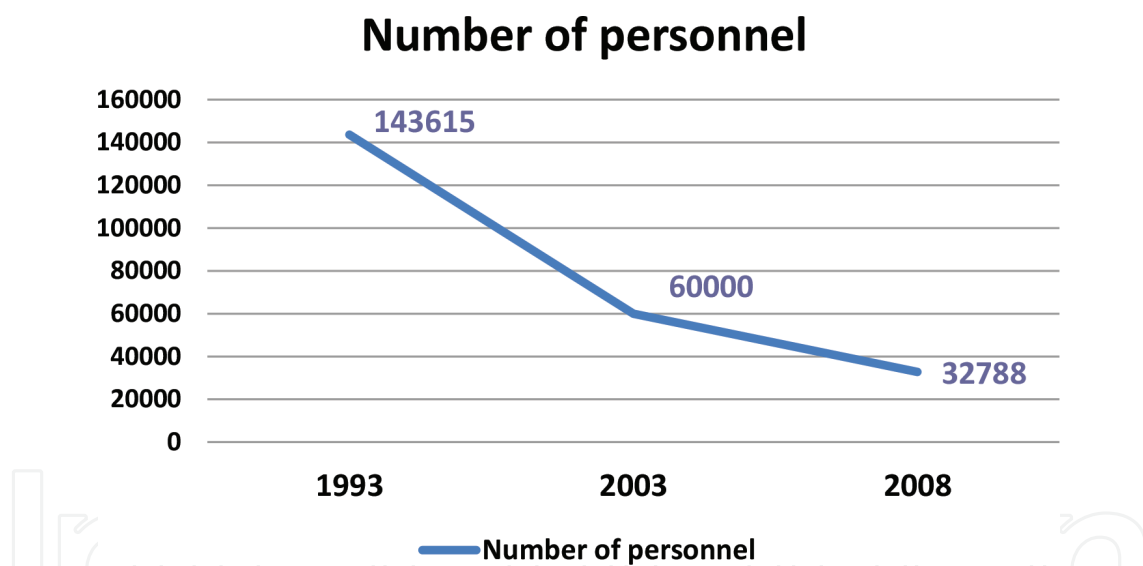


Figure 10. Involution of the number of personnel in the steel industry.

- Investments were made in technology and environmental protection amounting 787,531 million dollars.
- The restructuring benchmarks, as they were set out in the restructuring strategy, the viability individual plans and Annex VII of the Treaty of Accession (viability, productivity and cost reductions) were mostly achieved.
- The conclusion of the European Commission noted in 'COM 476 final: Third monitoring report on steel restructuring in Romania' was that the restructuring process during the transitional period has ended, in general, successfully.

### 3.3. Impact of the global crisis on the steel sector in Romania

- The start of the global economic-financial crisis, beginning in the second semester of 2008, has affected also the Romanian economy/steel industry.
- The significant decrease in demand for steel products resulted in performance indicators lower than those forecasted.

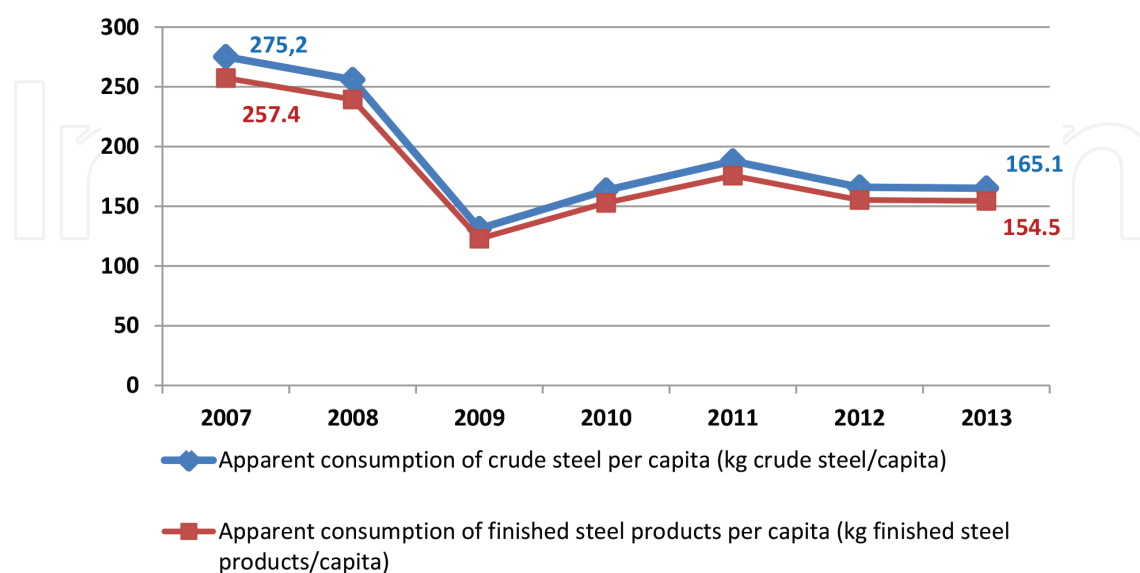
We note a drastic reduction at the level of 2009 by 54.5% (**Figures 11 and 12**).

- Withdrawal from Romania at the beginning of 2013 of the Mechel Group by selling the main share packages from COS Targoviste, Industria Sârmei Câmpia Turzii, Ductil Steel Buzău, Laminorul Brăila; the entry into insolvency of these companies and start of the process of judicial reorganization.
- The increase in imports particularly from non-EU countries (Ukraine, Turkey, China, etc.), has led to an increase in the trade deficit to about 1 million t of steel products (e.g. reinforcing steel, wire rod for drawing mills, flat coated products, semi-finished products, etc.).
- Uncontrolled and unpredictable growth of costs with the electrical energy, having as origin: the increase in energy price from producers; the increase of prices for services (transmission, distribution, etc.); implementation of the energy legislative package: climate changes; renewable energy, cogeneration fee.

In **Table 1**, the evolution of hot rolling capacities between 1993 and 2015 is shown.

We notice that the major differences between 1993 and 2015 can be found on Siderurgica Hunedoara/Arcelor Hunedoara (−9000 t, respectively, from 9600 to 600 t) and on Ispat Sidex Galati/ArcelorMittal Galati (−4200 t, respectively, from 11,000 to 6800 t).

In **Figure 13**, the evolution of steel, hot rolled steel finished products and tubes production is shown.



**Figure 11.** Evolution of the apparent consumption steel/finished products.

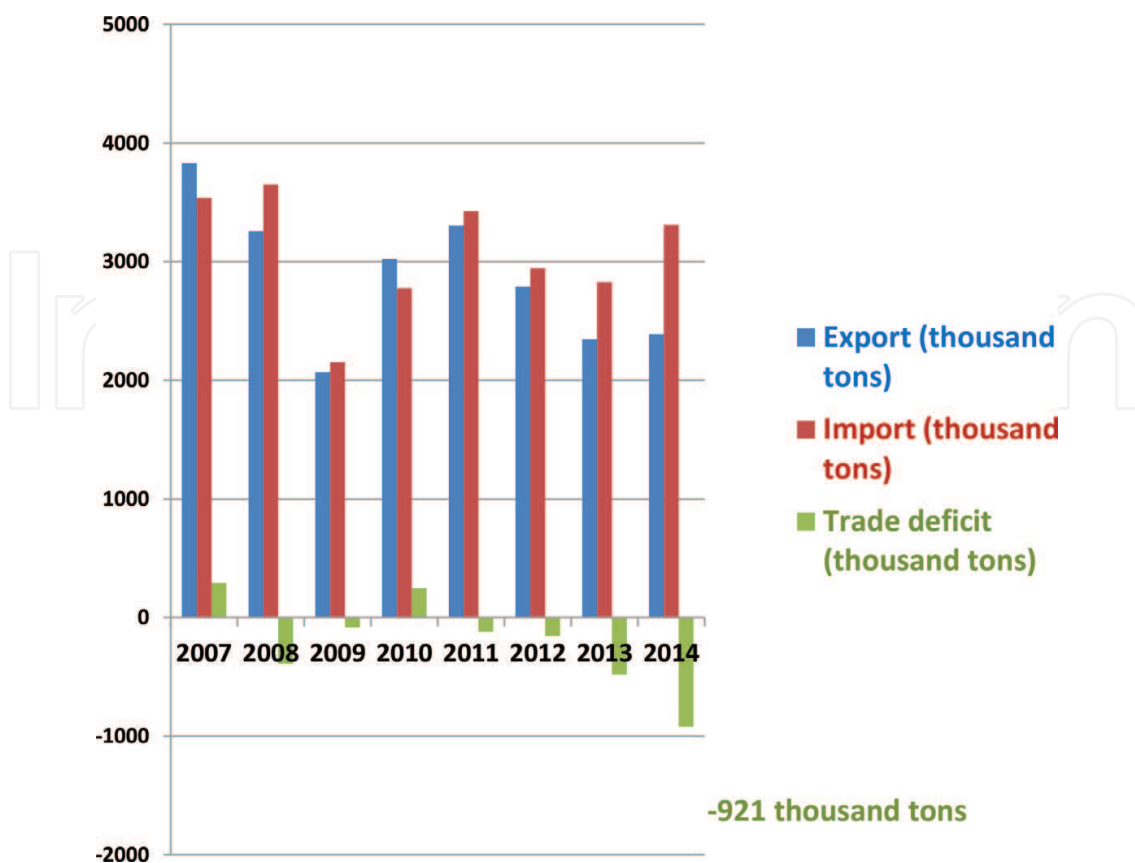


Figure 12. Evolution of the trade deficit of the iron and steel products.

### 3.4. Implementation of the recommendations contained in the action plan for a competitive and sustainable steel industry in Europe

- The policies in the field of energy, climate, resources and energy efficiency in order to stimulate competitiveness.
  - In order to reduce the impact of the factors mentioned on electricity price have been taken support measures for consumers (reduction of the number of green certificates, postponement of payment until 2017, reduction of the cogeneration tax, etc.), validated by normative acts.<sup>1</sup>
  - The State aid scheme regarding exemption of certain categories of final consumers of the enforcement of Law no. 220/2008 has been approved establishing the system for promoting energy production from renewable sources, drawn up based on the 'Guidelines on State aid for the environment and energy for the period 2014–2020',

<sup>1</sup>The Law 23/2014 for the approval of GDO 57/2013 regarding amending and supplementing Law no. 220/2008 establishing the system for promoting energy production from renewable sources. The Government decision no. 224/2014 for the approval of the share of electricity produced from renewable energy sources which benefit from the promotion system through green certificates for 2014. Order of the President of the ANRE no. 119/2013 on the approval of the contribution for high-efficiency cogeneration and of some provisions for billing thereof.

MINISTERUL ECONOMIEI,  
COMERȚULUI ȘI TURISMULUI

ROMANIA

EVOLUTION OF HOT ROLLING CAPACITIES BETWEEN 1993 - 2015  
(thousand tons)

Steel Plant	Capacity 1993	Capacity 2003	Capacity 2008	Capacity 2015	Difference 1995- 2015
ISPAT SIDEX Galati/ ARCELORMITTAL Galati	11.000	6.800	6.800	6.800	-4.200
SIDERURGICA Hunedoara/ ARCELORMITTAL Hunedoara	9.600	3.920	3.440	600	-9.000
COS Targoviste/ SC NIKAROM INVEST SRL	1.330	1.330	1.330	550	-780
IS Campia Turzii/ SC NIKAROM INVEST SRL	765	685	685	0	-765
CS Resita/ TMK Resita	1.510	1.390	1.050	0	-1.510
CS Otelu Rosu/ SC NIKAROM INVEST SRL	300	300	300	0	-300
DONASID Calarasi/ TENARIS Silcotub Zalau	1.870	1.520	1.520	0	-1.870
<b>TOTAL</b>	<b>26.375</b>	<b>15.945</b>	<b>15.125</b>	<b>7.950</b>	<b>-18.425</b>

5

5

**Table 1.** Evolution of hot rolling capacities between 1993–2015.

- adopted by the European Commission (COM) on April 9, 2014, being under implementation.
- The legal framework for the sale of certificates of greenhouse gas emissions has been created, i.e. the use of revenues obtained and for financing projects which are aimed at reducing the greenhouse gas emissions, including financing of research and development in the field of climatic changes.
  - Disparities in prices and average costs of energy, between the EU and its main competitors, shall be reduced in terms of achieving a regional market energy—one of the strategic objectives of the government.
  - All steel companies have in progress investment programs for improving energy efficiency/reduction of energy consumption and increasing the competitiveness of steel products.

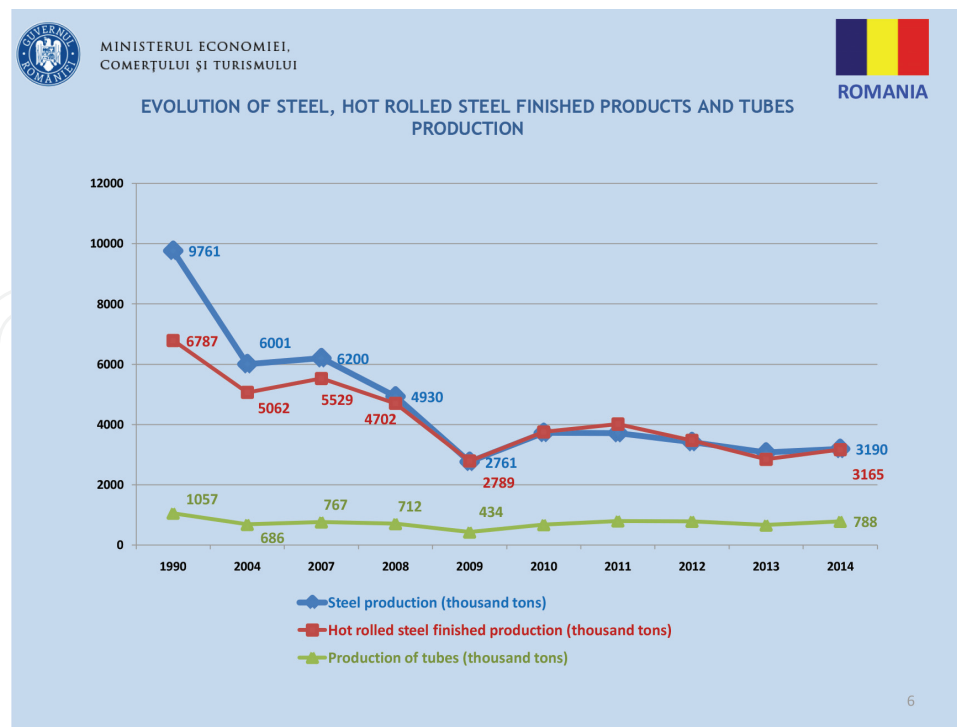


Figure 13. Evolution of steel, hot rolled steel finished products and tubes production.

- Social dimension: restructuring and the needs for competences.
  - Ensuring the legal framework for vocational training and retraining of workers by:
    - Law no 76/2002 on the unemployment insurance system and stimulation of employment, with subsequent amendments and supplements.
    - Law no. 279/2005 on apprenticeship at the workplace, with subsequent amendments and supplements.
  - The measures that concern the vocational training of workers in order to increase the adaptability to structural changes of the labour market have been proposed for additional financing from the European Social Fund through the 'Partnership Agreement 2014–2020'.
  - Structural Funds will also be used on a priority basis during the present programming period (2014–2020) for financing pre-layoff and stimulation of persons seeking employment.
  - It has been approved 'The National Strategy for Employment 2014–2020 and the Action Plan for the period 2014–2020 for implementing the National Strategy - GD 1071/2013'.
  - The social partners have made concrete proposals to governmental institutions empowered on the deficit of competencies.
  - The associations of employers are concerned with the continuing vocational training of employees (Exp. TenarisSilcotub Zalau, University Training Centre; ArcelorMittal,



Centre for Professional Training of employees and future employees; TMK, Centre of vocational training/training of employees, etc.)

- In 2013, it has been promoted the project 'Social Plant from Câmpia Turzii', in worth 7.1 million Euros, co-financed from the European Globalization Adjustment Fund (EGF); the project is addressed to workers made redundant (approximately 1000 employees) from the plant Industria Sârmei Campia Turzii.

### 3.5. Privatization, modernization/restructuring and monitoring between 2004 and 2008

- Completion of the privatization of all integrated steel mills and manufacturing companies, with strategic investors: ArcelorMittal, Tenaris, Mechel, TMK (2004).
- Starting the complex process of restructuring and modernization of steel sector by implementing the 'Restructuring strategy of Romanian steel industry and of the viability individual plans of steel companies for the period 2003–2008' validated by the European Commission in the context of closure of the negotiation of Chapter 6: Competition of the Accession Treaty.
- Romania became full participant within the Steel Committee of OECD, following the invitation received in 2005.
- Monitoring the Romanian steel sector by the European Commission (2005–2008).
- Conclusion of the European Commission published in 'COM (2010) 476 final: Third monitoring report on steel restructuring in Romania' stating that the restructuring process in the transitional period ended, generally, with success.

In the **Table 2**, the state of steel plants privatization in Romania is shown.

In **Figure 14**, the involution of the number of personnel employed in the Romanian steel industry is shown.

The striking decreases noted are as follows:

- Decrease by 58.2% between 1993 (143,500 absolute figure) and 2003 (60,000 absolute figure).
- Decrease by 45.4% between 2003 (60,000 absolute figure) and 2008 (32,788 absolute figure).
- Decrease by 41.2% between 2008 (32,788 absolute figure) and 2014 (19,300 absolute figure).

Consequently, the total reduction in the number of personnel from Romanian steel industry between 1993 and 2014 was of 86.6%, respectively, from 143,615 in 1993 to 19,300 in 2014.

### 3.6. Aspects of research and development agenda for metallurgical industry in Romania

The metallurgical sector in Romania has lost more than 200,000 jobs in the last 20 years, and it is one of the most affected areas of activity in our country because of the measures implemented following the agreements with the International Monetary Fund (IMF).



<div>  <div> MINISTERUL ECONOMIEI, COMERȚULUI ȘI TURISMULUI </div> <div>   ROMANIA </div> </div>				
State of steel plants privatization in Romania				
Company	Year of privatization	The majority shareholder at privatization	2015	Remarks
ISPAT - SIDEX Galati	2001	LNM Holdings	ARCELOMITTAL Galați	Flat products
SIDERURGICA Hunedoara	2003	LNM Holdings	ARCELOMITTAL Hunedoara	Long products
COS Targoviste	2002	Conares MECHEL Group	SC NIKAROM INVEST SRL	Long products
IS Campia Turzii	2003	Conares MECHEL Group	SC NIKAROM INVEST SRL	Long products
Otelu Rosu	2002	Gavazzi Steel Italia	SC NIKAROM INVEST SRL	Long products
CS Resita	2004	T.M.K. Sinara	TMK Reșița	Tubes
Donasid Calarasi	2003	Beltrame Italia	TENARIS Silcotub Zalău	Tubes

Table 2. State of steel plants privatization in Romania.

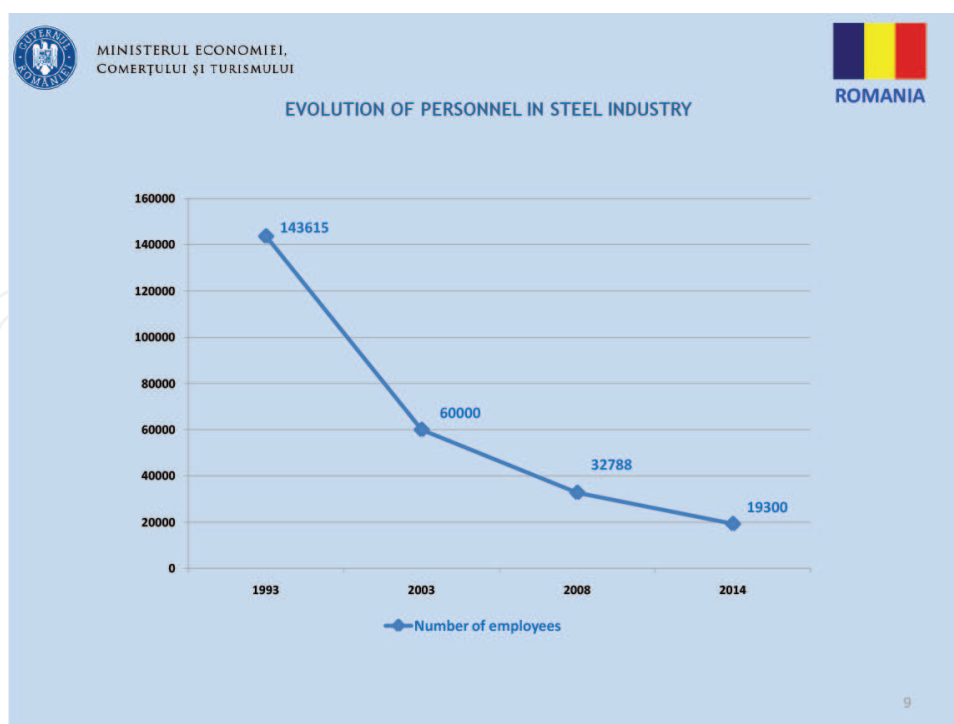


Figure 14. Involution of the number of personnel employed in the Romanian steel industry.

The main milestones in the involution of the siderurgical sector in Romania were the following:

- Creating the legislative framework for implementing the principles of the market economy and triggering the decentralization process of the state economy (since 1990).
- Ratification by Law 20/1993 of the Association Agreement of Romania to EU and adjacent to it of the Protocol no. 2 ECSC;
  - i. Establishing the Contact Group ECSC Romania, EU.
  - ii. Initiation of the full trade liberalization program.
  - iii. The foundations of the complex process of restructuring of the Romanian siderurgical sector.
  - iv. Romania becomes in national premiere due to the siderurgical sector, Observer Member of Steel Committee from the OECD (1993).
- Complete privatization of all the integrated siderurgical enterprises and manufacturing companies, with strategic investors: ArcelorMittal, Tenaris, Mechel, TMK, SAMSUNG, etc. Erdemir (2004).
- Adopting a siderurgy restructuring plan in accordance with EU requirements and its implementation (Government Decision no. 213/2002).
- Development, approval by the government of the 'Restructuring Strategy of the Siderurgical Industry in Romania and of the Individual Viability Plans for the Siderurgical Companies in 2003–2008 (GD no. 55 of January 2005) and its validation by the European Commission in the context of closing Chapter 6: Competition
- EU Accession Treaty Signing (March 2005) in which in Annex VII there are comprised the following:
  - The basic principles of the siderurgy restructuring
  - Interface elements of government: siderurgical companies
  - The commitments taken in order to ensure the economic and financial viabilization of all siderurgical companies by 2008
  - Restructuring process monitoring; drawing by the MEC of the biannual reports and sending them to the European Commission (2005–2008).
- Becoming a Full Member of the Steel Committee of the Organization for Economic Cooperation and Development (October 2005).
- Performing the Restructuring Process in the Siderurgical Companies in accordance with the provisions of the strategic documents amid the favourable demand for steel in the market (2005–2008).
- The Results of the restructuring monitoring are as follows:

- The restructured companies ArcelorMittal Galati, ArcelorMittal Hunedoara, COS Targoviste, Campia Turzii Wire Industry, TMK Resita and Tenaris Calarasi represented in 2008 a share of above 90% of the Romanian crude steel production.
- The state aid worth of 1.52 billion Euros was focused first on the financial restructuring (debt to equity conversion, prescribing debts for utilities) and to a lesser extent on the exemption from taxes (VAT and corporate income tax).
- After 2004, it was neither given nor paid any state aid, to any of the companies mentioned or to any other steel producer in Romania.
- There were reduced the steel production capacities, the lamination capacities and the number of employees in the steel industry

### **3.7. Implementation of the recommendations contained in the action plan for a sustainable and competitive siderurgical industry in Europa COM (2014–2020)**

- The policies on energy, climate, resources and energy efficiency to boost competitiveness:
  - To reduce the impact of the factors mentioned on the electricity price, support measures have been taken for consumers (by reducing the number of green certificates, payment deferral until 2017, the cogeneration tax reduction, etc.), validated by laws.
  - It was approved a state aid scheme exempting certain categories of end users from Law no. 220/2008 in order to establish the system for promoting energy production from renewable sources based on 'The Guidelines for Environment and Energy Aids for 2014–2020' adopted by the European Commission (COM) on April 9, 2014, which is in the process of being implemented.
  - A legal framework has been created to capitalize the emissions of greenhouse gases, respectively, the use of the revenues obtained for financing projects aimed at reducing emissions of greenhouse gases, including financing research and development on climate change.
  - Disparities on prices and average costs of energy between the EU industry and its main competitors will be reduced in order to create the regional energy market—one of the government's strategic goals.
  - All siderurgical companies have on-going investment programs for improving energy efficiency/reducing energy consumption and increasing the competitiveness of the siderurgical products.
- The social dimension: restructuring and the skill needs
  - Providing the legal framework for professional reconversion and retraining workers by means of the following:
    - Law 76/2002 on the unemployment insurance system and employment stimulation with the subsequent amendments and completions.
    - Law 279/2005 on apprenticeship at work, as further amended and completed.

Law 23/2014 for approving Government Emergency Ordinance 57/2013 on amending and completing Law no 220/2008 in order to establish the system for promoting energy production from renewable sources.

Government Decision no. 224/2014 for the approval of the share of electricity produced from renewable energy sources which benefits from the promotion system through green certificates for 2014.

ANRE's President's Order No.119/2013 on approving the contribution for high efficiency cogeneration and certain provisions regarding its billing:

- Measures aimed at training workers to increase the adaptability to the structural changes of the labour market have been proposed for additional funding from the European Social Fund through the 'Partnership Agreement 2014–2020'.
- Structural Funds also will be used first and foremost in the current programming period (2014–2020) to finance pre-dismissals and stimulate people looking for a job.
- The 'National Strategy for Employment 2014–2020 and the Action Plan for the 2014–2020 have been approved in order to implement the National Strategy - GD 1071/2013'.
- The social partners have made concrete proposals to the authorized governmental institutions on skills shortages.
- Employers are concerned about the continuous training of employees (Exp. TenarisSilcotub Zalau, Academic Training Centre; ArcelorMittal. Centre for Professional Training of Employees and Future Employees; TMK, Professional Training Centre for Employees, etc.).
- In 2013 'The Campia Turzii Social Enterprise' project was promoted amounting to 7.1 million Euros, co-financed from the European Adjustment Fund for Globalization (EGF); the project addresses the dismissed personnel (approximately 1000 employees) from Campia Turzii Wire Industry Enterprise.

According to the '**Winter Forecast for 2015 of National Commission of Prognosis,**' the projection of the main indicators for the 2014–2018 is as follows:

	2013	2014	2015	2016	2017	2018
GDP—real increase (%)	3.4	2.9	2.8	3.0	3.3	3.5
Industrial production for the metallurgical/siderurgical industry (%)	–7.8	4.4	1.8	2.3	3.3	3.6

The industrial production forecast shows a slight recovery of metallurgical/siderurgical industry compared to 2013; but in order to achieve this, the metallurgical companies in Romania should be concerned with the following:

- alignment generalization with best available techniques (BAT) in metallurgy in order to optimize their environmental performance;
- maintaining the activity at a competitive level compared to the evolution of the energy costs;



- increasing productivity through improving the use of the material and energy resources;
- further implementation of the provisions of HG. Nr. 495/2014 on instituting a state aid scheme to exempt certain categories of end users from Law no. 220/2008 in order to establish the system for promoting energy production from renewable sources, with the subsequent amendments and completions;
- further implementation of the recommendations of the ‘Action Plan for the Future of the Siderurgical Industry [COM (2013) 407]’ on energy efficiency, CO<sub>2</sub> emissions reduction, allocating funds from capitalizing on emissions, for research and development, accessing structural funds for professional reconversion, etc.

4. The prospects of metallurgical industry in Romania

- According to the ‘2015 Winter Prognosis of the National Prognosis Commission’ projection of the main indicators for the period 2014–2018 shall be in the following format (Table 3).
- Industrial production forecast shows a slight recovery of the metallurgical/steel industry compared to 2013; but for achieving this, metallurgical companies in Romania should be concerned with the following goals:
  - generalization of alignment to the best available techniques (BAT) in metallurgy in order to optimize their environmental performance;
  - maintaining activity to a competitive level in relation to the progress made in the energy costs;
  - to increase productivity by improving the use of material and energy;
  - to continue the implementation of provisions of ‘GD. No 495/2014 on the establishment of a state aid scheme to exempt certain categories of end users from Law no. 220/2008 establishing the system for promoting energy production from renewable energy sources, with subsequent amendments and supplements’;
  - to continue implementing the recommendations of the ‘Action Plan for the future of steel industry [COM (2013) 407]’ on energy efficiency, to reduce CO<sub>2</sub> emissions, to allocate funds from the sale of the certificates of emissions to research and development, to access the structural funds for professional reconversion, etc.

	2013	2014	2015	2016	2017	2018
GDP—actual increase in %	3.4	2.9	2.8	3.0	3.3	3.5
Industrial production for the metallurgical/steel industry %	–7.8	4.4	1.8	2.3	3.3	3.6

Table 3. Percentage changes compared to the previous year (%).

## 5. Technical-economic components specific to metallic materials industry

In the industry of the metallic materials are used several kinds of energy for operation, among which the most important are the following:

- *the burning of fuels* and
- *the electrical energy.*

In the case of technical-economic analyses which are made in metallurgical enterprises, the consumptions in the area of the two energy sources (furnaces with combustion and electric furnaces) should be coherently expressed by the same indicator, which is the *specific consumption of primary energy*. The equivalence of the various forms of primary energy  $E_p$  [HJ/t] depending on the energy registered  $E_i$  [HJ/t or Kwh/t] to a certain furnace shall be made using the relation:

$$E_p = eE_i \quad (1)$$

where

$E_i$  is the consumption registered (or calculated) in kWh/t to the electric furnaces and MJ/t to the combustion units.

$e$  is the coefficient of equivalence.

The primary energy is the energy in the natural sources (deposits) of *fossil or primary fuels* (coal, natural gas, oil). It may be assessed based on the quantity of fossil fuel ( $m_{cf}$ ) and on the calorific value of the latter in raw state  $H_{cf}$ .

$$E_p = m_{cf} \cdot H_{cf} \quad [\text{MJ}] \quad (2)$$

In the case where to combustion furnaces, energy consumption is given in the form of the specific consumption of fuel  $B_s$ , [kg; m<sup>3</sup>N comb./t] with lower calorific power  $H_i$ , then the relation of equivalence is:

$$E_p = e \cdot B_s \cdot H_i \quad (3)$$

If it is intended to calculate the consumption of primary energy in consumptions of conventional fuel of calorific value  $H_{c.c} = 29$  MJ/kg, then the transformation is given by:

$$E_{p.c.c} = \frac{E_p}{H_{c.c}}, [\text{kg c.c./t}] \quad (4)$$

In the relations from above,  $e$  represents the equalization coefficients in primary energy of the various types of energies used by the unit. The recommended values for these coefficients are as follows:

- $e_c = e_p = e_{g.n} = 1 \text{ MJ/MJ}$  for coal, crude oil and natural gas.
- $e_k = 1.2 \text{ MJ/MJ}$  for coke and
- $e_{e.e} = 10 \text{ MJ/KWh}$  for the case of using electricity.

In order to understand the essence of the transformation of energy consumption registered at the metallurgical thermo-technological facility ( $E_p$ ) in primary energy ( $E_p$ ) we recommend consulting the scheme in **Figure 15** which shows the case of the electric arc furnace (EAF) for steelmaking based on consumption of electrical energy (EE) produced in electric power plants (EPP) fuelled with natural gas extracted from the deposit (D). The transport of natural gas and electricity is carried out on the routes  $T_1$  and  $T_2$ .

In the analysis performed we should keep in mind:

- the extraction and transport  $T_1$  of natural gas requires minimal energy consumptions and losses expressed as a percentage by the yield  $p_1$ ;
- the conversion of natural gas into electrical energy in the EPP (electric power plants) is done with the yield  $p_2$  (in Romania yield of the EPP is usually of 30–40%);
- the transport  $T_2$  means the consumptions and losses measured by the yield  $p_3$ ;
- consumption registered  $E_i$  to the EAC expressed in Kwh should be amplified with 3.6 in order to be obtained in MJ;

Based on the observations from above is obtained:

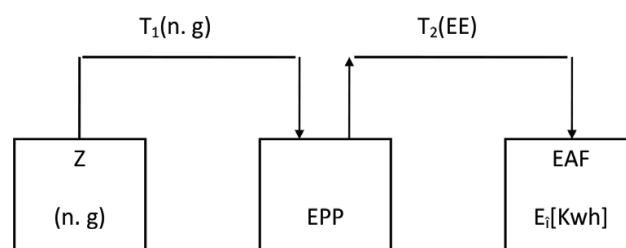
$$E_{p(z)} = 3.6 \frac{E_i(\text{CAE})}{p_1 \cdot p_2 \cdot p_3} \quad (5)$$

It may be inferred that:

$$e_{e.e} = \frac{3.6}{p_1 \cdot p_2 \cdot p_3} \quad (6)$$

If it is considered that  $p_1 = p_3 \cong 1$  and is taken into account only  $p_2$  with the value of 0.35, it results that:

$$e_{ee} = \frac{3.6}{0.35} \cong 10 \text{ MJ/Kwh} \quad (7)$$



**Figure 15.** The route of transforming the primary energy of natural gas in energy source of the EAF.

In the analyses which the metallurgical thermodynamics requires regarding the estimates in primary energy, the coefficients  $e$  defined above must not be confused with the reports for equivalence from physics (860 kcal/kWh, 3.6 MJ/Kwh or 427 kgf.m/Kcal).

For concretization and elucidation, we offer the example below.

At an EAC for steelmaking is registered an electricity consumption of  $E_i = 500$  Kwh/t of steel. This means that the deposit of natural gas must provide a quantity of primary energy equal to:

$$E_p = 500 \cdot 10 = 5000 \text{ MJ} \quad (8)$$

Knowing that the calorific value of the natural gas is  $H_{i-g,n} \cong 34 \text{ MJ/m}_N^3$ , it results that in order to obtain 1 t of steel in the EAC are consumed at the deposit:

$$m_{cf(g,n)} = \frac{5000}{34} \cong 147 \text{ m}_N^3 \times g \times n/t_{otel} \quad (9)$$

If it is intended to measure in conventional fuel, is obtained:

$$m_{pcc} = \frac{5000}{29} = 172 \text{ Kg.c.c/t}_{otel} \quad (10)$$

In metallurgy, the consumption of natural resources is represented by the consumptions of fuels, energy, raw materials and auxiliary materials.

The consumption of production factors may be analysed both per entire production, in one way or another, named also global consumption, as well as per unit of product or result obtained (a car, a tonne of steel, furniture, an electronic computer, an apartment, etc.).

In regards to the quantitative side of the production factors, entrepreneurs involve them in a different way. So, in the short term, in order to increase production, they resort to hiring more workers and additional raw materials and supplies, in the conditions under which the factor fixed capital remains constant.

In the long term, all production factors are variable, because the increase of production involves changes in all production factors, including the fixed capital (e.g. in order to enhance production, the economic agent may also resort to a new facility of larger size, which can be achieved only in the long term). Of course, quantitative increase of production factors must be accompanied by the pronounced increase of yields that are obtained in their use.

The consumption of production factors has a **dynamic nature**, being different in time, depending on the production volume, the scientific and technical progress, which entails further improvements in the endowment with factors and reducing specific consumption.

Consumption is an economic indicator with a great force of mirroring of the quality of the activity. By reporting the results of consumptions, the efficiency of using the allocated resources may be known. Consumption serves as an underlying criterion for the options and decisions of each producer; in the case where the effects or results of the project variants are

identical, the criterion of choosing the optimal variant is represented by the lower level of consumption.

The size of consumption can be seen in one of the following options:

- a. per product unit (a tonne of aluminium, a tonne of wheat or of fruit, a cubic meter of methane gas, a machine tool, a car, etc.);
- b. per whole production achieved by a company or another and;
- c. over a certain period of time.

According to above, the metallurgical economic engineering is to be operated with:

**(a) Unitary or specific consumption ( $S_c$ )**, which represents the consumption per product unit or per unit of useful effect (in metallurgy, these are, usually, per tonne of metal material manufactured); it results that  $S_c$  is measured in kg fuel; material per tonne of product or J; kWh/t of product.

**(b) Global consumption ( $G_c$ )**, which constitutes the consumption corresponding to a given production volume (usually, the production capacity  $Q$ , measured in tonnes of product).

The consumption from above may be:

- **Integrated consumption**, which makes reference to the situation per a whole technological flow.
- **Partial or sequential consumption**, which describes the integrated consumption per one segment (sequence) from a flow.

**(c) Temporal consumption ( $T_c$ )**, which represents the consumption registered in the time unit; can be measured in t, J, kWh/hour, day, month, year.

**(d) Marginal consumption ( $M_c$ )** is given by the supplement (gain) of consumption in order to obtain an additional product unit at a given moment. Being of specific nature, it is determined by relating the growth of global consumption ( $\Delta G_c$ ) to the increase of production ( $\Delta Q$ ):

$$C'_m = \Delta G_c / \Delta Q \quad (11)$$

The size of consumption for the whole production ( $G_c$ ) is dependent on the quantity of products obtained ( $Q$ ) and unitary consumption ( $S_c$ )

$$C'_m = f(Q, C_s) \quad (12)$$

The size of consumption per product unit is different, as follows:

- a. from one product to another, depending on the specific nature of each, on the consumption of factors which it requires;
- b. from one and the same product, from one manufacturer to another, as a result of the endowment with different factors; and



- c. at one and the same manufacturer, from a period to another, in dependence on the changes in the technical endowment, in the level of qualification of workers, in the organization and management, etc.

At the flow integrated into the EAC, reducing the electricity consumption is sought to be achieved, mainly, by optimizing the use of renewable energy sources available through technological actions (oxygen blowing through the fireplace, post-combustion, the technology with slag foaming, preheating scrapping, etc.) reducing the waiting time at hot and, respectively, by improving the equipment and conductivity of the thermal and electrical system. The option to supply the EAC in direct current (DC) is accredited with a small reduction of electricity consumption (approximately 5 kWh/t).

Potential resources somewhat higher for reducing fuel consumption will be brought by the third generation of continuous casting plants (CC) namely, by making the blank look somehow like the final steel product. From this point of view, in the industrial advanced phase, with development perspectives, is the thin slab casting, followed closely by the direct taking of hot rolled strip.

**The integrated consumption of primary energy** shall be calculated at steel mill level in GJ/t crude steel. It has reached an average of about 19.3 GJ/t (about 660 kg cc/t), which for current technologies seems to be the '**minimum technological**'. In the situation where the additional consumption is not taken into account are related to:

- environmental protection;
- age of the main equipment on the steel flow; and
- the deepening of processing in order to increase the share of products with high added-value, the lower limit of the minimum technological should be about 18.2 GJ/t (approximately 620 kg cc/t).

**The coefficient of 'energy independence'** ( $E_c$ ) defines the share of the energy taken from the national system and from third parties (like coke, gas, oil products, etc.), which is returned to other consumers from economy. The relation of defining is:

$$C_e = \frac{E_{ic} - E_{oc}}{E_i - E_o} \cdot 100 \quad (13)$$

In which:

$E_{ic}$  is primary energy from the additional coal and coke purchased from the outside, GJ;

$E_{oc}$  is energy delivered to the outside like coke, breeze coke, by-products of coke plant (tar, oil, etc.), GJ;

$E_i$  is the primary energy from the outside (coal, coke, electricity, oil products, etc.) used in the steelmaking process, GJ;

$E_{an}$  is energy delivered by the steel mill as steam, electricity, fuel gas, GJ.

In the case of steel mills optimized in terms of energy, with appropriate use of their own energy resources, that coefficient has a value of over 100%.

- The achievement of a share of the gross profit rate (GPR) from the exploitation activity (manufacturing):

$$RPB = \frac{P_{rb}}{CA} \times 100 > 13.5 \% \quad (14)$$

(fuel and energy having a significant share in total costs, therefore influencing the value  $G_{pr}$ ).

Romania's economy has registered in the period after 2000 recoveries. Thus, if in 2000, GDP per capita of Romania was approximately 33% of that of the Czech Republic, in 2013 gets to be about 41%, therefore a recovery of eight points in the economic offset between the two countries. This fact results also from the level of the average annual growth rate (AAGR) occurring in the period 2000–2013 which in the case of Romania is almost 84% above that of the Czech Republic (3.73%/year against the 2.03%/year).

Quantifying the impact of main sectors in the economy in the GDP is performed by the extent of the **gross value added (GVA)**.

In **Table 4**, the evolution of the impact of metallurgy in the GDP is shown.

In **Table 5**, the evolution of performance (GVA) of steelmaking sector (USD<sup>2010</sup>/t) in some EU states is shown.

In **Table 6**, the impact in the GDP of the two sectors, non-ferrous metallurgy and founding, impact defined in % of the steelmaking sector is shown.

In the context of steelmaking sector, decline in the year of maximum intensity of the crisis, the share of both sectors (non-ferrous and founding) in relation to the steelmaking industry

	2007	2008	2009	2010	2012	2013
France	0.476	0.399	0.210	0.309	0.229	0.234
The United Kingdom	0.376	0.362	0.282	0.256	0.210	0.243
The Czech Republic	1.50	1.167	0.555	0.639	0.660	0.770
Poland	0.97	0.748	0.396	0.452	0.471	0.430
Romania	0.880	0.912	0.152	0.152	0.448	0.344

**Table 4.** Evolution of the impact of metallurgy in the GDP (% of GDP).

		2000	2007	2008	2009	2010	2012	2013
France	USD <sup>2010</sup> /t	....	....	341	276	264	190	194
The United Kingdom	USD <sup>2010</sup> /t	....	....	354	163	248	217	225
The Czech Republic	USD <sup>2010</sup> /t	....	....	289	165	162	157	204
Poland	USD <sup>2010</sup> /t	....	....	217	144	168	180	173
Romania	USD <sup>2010</sup> /t	....	....	268	43	120	182	133

**Table 5.** The evolution of performance (GVA) of steelmaking sector (USD<sup>2010</sup>/t) in some EU states.

		2007	2008	2009	2010	2012	2013
France	Non-ferrous	....	35.2	37.5	57.4	60.7	61.1
	Founding	....	34.2	48.6	44.3	48.1	47.8
The United Kingdom	Non-ferrous	....	66.5	156.9	118.4	105.8	93.7
	Founding	....	20.2	45.9	37.7	43.7	34.3
The Czech Republic	Non-ferrous	....	7.2	14.6	18.5	20.8	16.9
	Founding	....	26.9	33.9	34.3	53.9	35.7
Poland	Non-ferrous	....	20.2	34.9	28.4	28.0	30.7
	Founding	....	24.7	42.9	31.9	31.0	40.8
Romania	Non-ferrous	....	17.6	79.8	55.3	27.0	34.9
	Founding	....	5.7	45.0	12.9	10.8	17.2

**Table 6.** The impact in the GDP of non-ferrous metallurgy and founding, as % of steelmaking.

increases. It is to be noticed that further, after 2009, the share of both sectors in relation to the steelmaking industry, shall be maintained at rates higher than in the pre-crisis phase. This fact proves the usefulness in the GVA of these sectors. Unfortunately, by occult interests, Romania has 'beheaded' many of its production bases for these sectors.

The founding sector (cast iron, steel, non-ferrous) in Romania, in relation to the steelmaking industry, has in the GDP a contribution of less than 50% compared to the contribution of the steelmaking sector. Probably if there were solutions for the maintenance of a larger quota of the strong manufacturing base, existing before 1990—under the conditions of drastic reduction of the steel production—the effect would have been with approximately 15% over the present achievements.

Noting that the non-ferrous sector is now present, mainly, only by the industry of aluminium, whose impact in the GDP—in the circumstances of a significant 'decline' of steel sector in 2009 and 2013—is significantly above the achievements of steelmaking industry in the GVA/t (Euro/t).

Accustomed to the high tonnage of steel production in an economy, in relation to the overall tonnage of non-ferrous metallurgy (metal including alloys of Al; Cu; Zn; Sn; etc.) or castings (cast iron, steel or non-ferrous), the rate of impact in the GDP of the two sectors mentioned (non-ferrous and castings), seems surprising. We consider useful the following explanations:

- The price in the market of laminates from metals/non-ferrous alloys is a few times higher than that of the laminates of steel.
- The cast piece is not only a raw material in the economy but also a finished product that gathers a share of the machine building activity, so it has a price in the market over the material from which it is derived (non-ferrous, cast iron, steel).
- From the data available on the Internet on the total production of cast pieces (**Table 5**), it results that the GVA/t has been in 2008 in the United Kingdom of 1211 Euro/t and in

Romania of 487 Euro/t, compared to the average on the steel industry which has been in the United Kingdom of 192 Euro/t and in Romania of 186 Euro/t.

In the production of aluminium of 2008, GVA level/t—in the United Kingdom—was of 1586 Euro/t and in Romania in the same year, the estimated value of the GVA was of 660 Euro/t.

## 6. Conclusion

Metallurgy is a component of the processing industry. It provides the necessary materials for the development of industrial activities to cover certain needs of the daily life such as the building machines industry, the civil and industrial constructions, energy industry and of the fuel and energy supply industry, the transport industry (road, sea, air), the defence industry, etc.

Basically, today, life is unthinkable also in the future without the existence of the various products of the metallurgical/steel industry.

Often the confusion is made between the necessity of existence of metallurgical products and the opportunity of manufacturing them in an economy. There are also 'lobbyists' interested in maintaining this confusion.

The global financial and economic crisis has affected also the Romanian economy/steel industry.

The significant decrease of production and associated steel demand has resulted in further reduction of production capacities and of the number of employees.

Increase in imports especially from non-EU countries (Ukraine, Turkey, China, etc.), (e.g. Concrete steel, wire rod, flat coated products, semis, etc.),

Increase in uncontrolled and unpredictable way of energy costs, as a result of implementing energy legislative package—climate change.

Crude steel production in Romania has registered, in 2015, an increase by 4.8% compared to the level of 3.1 million t in 2014. But, sales registered by this sector decreased in 2015 by 5.1%.

Metallurgical sector in Romania has lost, over the past 20 years, over 200,000 places of employment, being one of the most affected areas of activity in our country by the measures implemented as a result of the agreements concluded with the International Monetary Fund (IMF).

Immediately after the Revolution in 1989, approximately 250,000 employees were working in the metallurgical sector in Romania. Following the measures implemented on the basis of agreements concluded with the International Monetary Fund (IMF), metallurgy relies, at present, only on 25,000 professionals. Although it has been privatized for an insignificant amount, of just 50 million dollars, Sidex Galati Steel Plant is nevertheless a happy example, because it still exists under the current name of ArcelorMittal. In most cases, however, metallurgical plants have disappeared completely, being privatized through winding up.

Romania is a part of the second group of countries, from the point of view of the European states most affected by the austerity measures imposed by the IMF.

Austerity measures imposed by the IMF have produced the toughest effects socially in Greece; however Romania is part of the second group of countries, from the point of view of the European states most affected by these economic decisions. In the current context, we need to try and see in what way the civil society organizations may determine a change of attitude of international financial institutions in order to make them more responsible toward citizens.

In 2015, there has been noticed an increase of production capacities in almost all metallurgical sectors. The largest increases in production capacities were registered for electric crude steel (+58.5%), for cast iron and ferro-alloys (+19.6%), for crude steel (+11.1%), for long hot-rolled products (+10.8%), for mixture making (+10.6%), as well as for products obtained by cold-rolling (+10.0%).

Metallurgical sectors in which were registered decreases in production capacities were those for steel used for continuous casting (−11.2%) and products obtained from hot rolled products (−10%).

But from the point of view of using production capacities in 2015, it is noted that in the coke, cast iron and ferro-alloys sectors, capacities are used in a proportion of 96.2%, compared to 96.8% in 2014.

Crude steel production plants are used to 66.6% of the capacity compared to 70.6% in 2014, noting also a slight decrease in both coke, cast iron and ferro-alloys and in the crude steel production plants compared to the previous year.

Investments have increased by almost 70%. In 2015, the total expenses for investments in the metallurgical sector amounted to 337.4 million Lei, increasing, in nominal terms, by 67.9% as compared to 2014.

In 2015, investments in most metallurgical sectors have registered growths, but most of them are directed to: rolling mills with 58.6%, rolling mills for cold rolling strips 27.5%, steelworks with 23.8% and flat products with 20.3%.

In exchange, the expenses for environment protection represented 4.9% of the total investment costs, registering a decrease of 10.3% as compared to 2014, says the NIS.

The power consumption of the equipment and steel plants was of 1605.3 GWh (76.8% of consumption), the quantity of 484.2 GWh (23.2%) being used by the auxiliary facilities and internal services.

Per types of equipment and steel plants, the share of the electricity consumption registered is owned by rolling mills (540.6 GWh, respectively, 33.7%), followed by the steelmaking capacities (447.8 GWh, respectively, 27.9%) and electric furnaces for melting and continuous casting (441.5 GWh, respectively, 27.5% of the power consumption of steelmaking equipment and plants).



The gross consumption of energy in the metallurgical industry in 2015 was of 61,244.5 TJ, increasing by 11.8% as compared to the previous year.

Of this consumption, 52.7% has been used for the preparation of the load for blast furnace, 19.4% for other uses, 11.8% for the production of cast iron, 7.0% for the production of steel and 5.5% for rolling mills.

From the point of view of the fuels used in the metallurgical industry, solid fuels hold in 2015 a share of 52.8% (48% in 2014), gaseous fuels 33.5% (36.7% in 2014), while the electrical energy has registered a share of 12.1% (13.0% in 2014).

Of the total of solid fuels, 33.7% represents the coke, the main fuel used in the metallurgical industry.

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