ГОДИШНИК на Минно-геоложкия университет "Св. Иван Рилски", Том 52, Св.III, Механизация, електрификация и автоматизация на мините, 2009
ANNUAL of the University of Mining and Geology "St. Ivan Rilski", Vol. 52, Part III, Mechanization, electrification and automation in mines, 2009

# LIFE-CYCLE ASSESSMENT OF STEEL CONSTRUCTIONS IN CZECH REPUBLIC

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**ABSTRACT.** Paper deals with life-cycle assessment of steel constructions in Czech Republic. We survey the flow between its particular stages (raw materials mining, processing, production of raw iron, production of raw steel, production of semi-finished products, production of steel constructions, consumption and disposal) and environment. Very detailed information was obtained about inputs and outputs. Better accuracy of information is gained by presentation methodology. Conversion and recalculation of data from production of raw steel and production of semi-finished products according specific standards are mentioned. Specific standards are deriving from structure prefabricated elements, which are used for production of steel constructions in monitored company.

**ОЦЕНКА НА ЖИЗНЕНИЯ ЦИКЪЛ НА СТОМАНЕНИ КОНСТРУКЦИИ В ЧЕШКАТА РЕПУБЛИКА**

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**РЕЗЮМЕ.** В статията се прави оценка на жизнения цикъл на стоманени конструкции в Чешката Република. При направеното проучване е получена много детайлна информация на входа и изхода за връзките между отделните жизнени етапи (суровина, добив, преработка, производство на желязо, производство на сурова стомана, производство на полуготови продукти, производство на метални конструкции, потребление и пласмент) и околната среда. Представена е методологията чрез която се получава по-точна информация. Споменатите преобразувани и преизчислени данни относно продукцията на сурова стомана и производството на полуготови продукти са съгласувани със специфичните стандарти. Специфичните стандарти, произтичат от структурата на сглобяемите елементи, които се използват за производство на стоманени конструкции в наблюдаваните дружества.

## Introduction

If we want to make the good decisions, we must have good-quality information. For that reason Life-cycle of steel structures was created from most detailed information, and is also adhered to principle of maximum transparence of used information´ s correction and calculation. The Life-cycle of steel structures was created in conformity with European Union legislations (ISO 14 000), and all obligate stages of product's life-cycle assessment were done (definition of the purpose and the immensity, inventory analyses, analyses of environmental impact and interpretation).

## Creation of life-cycle of steel structures

Life-cycle has the following stages:

- iron ore mining and preparation, sinter and iron production, steel production, rolled stock production, steel structure production, steel structure servicing and repairing, steel structure disposal.

Life cycle was created from primary information, which had been given to author by main producers of iron and steel in Czech Republic, and from secondary information. Secondary information was taken from information databases of Czech Environmental Department (IRZ and EIA databases), information databases of Czech Trade and Industry Department (IPPC database) and information databases of European Union (BREFF documents).

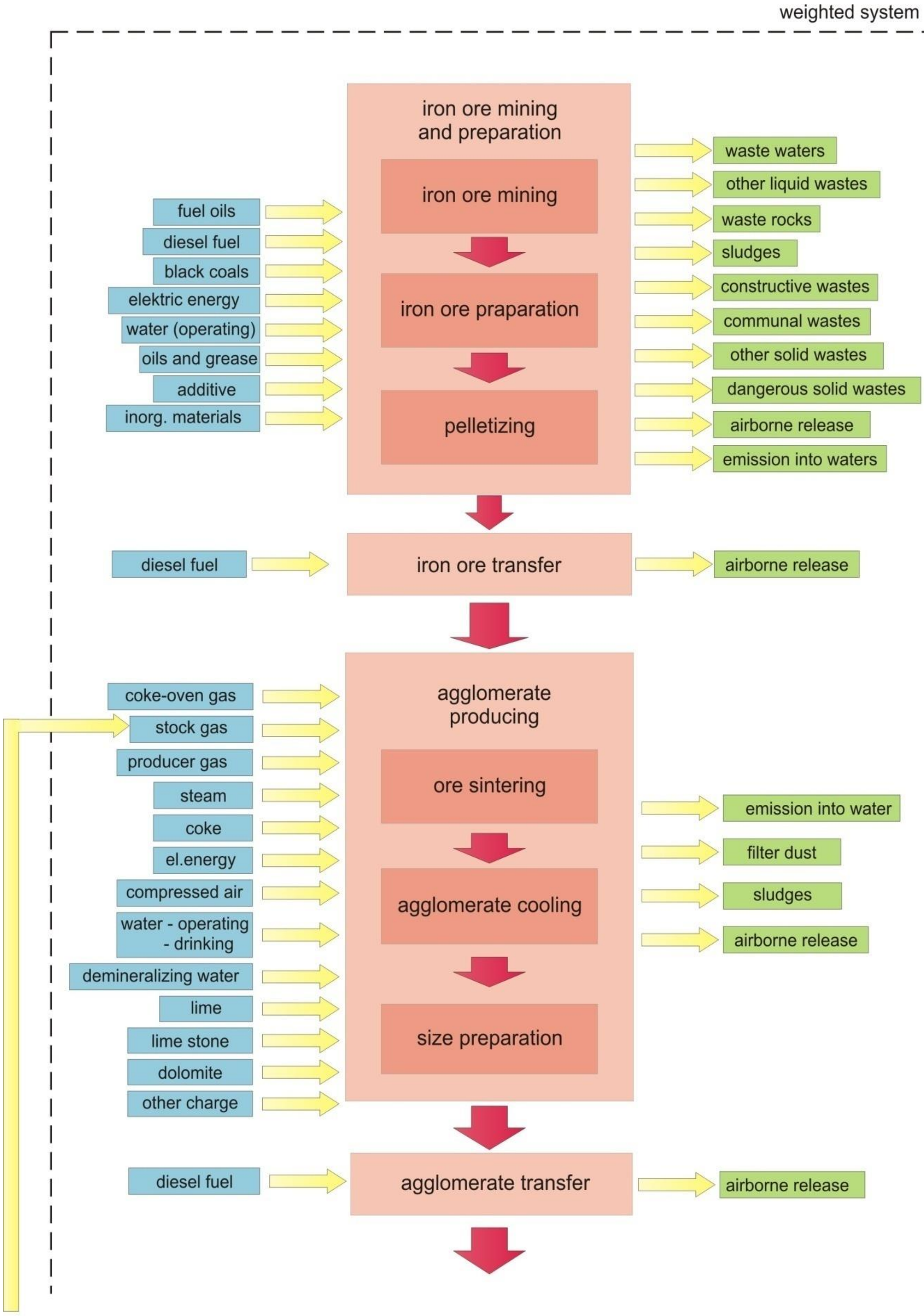
Due to maintaining detailed information of creating life-cycle was created all life-cycles of external products in the same way. External products are products, which input to life-cycle of steel structures. There was created following simple life-cycles:

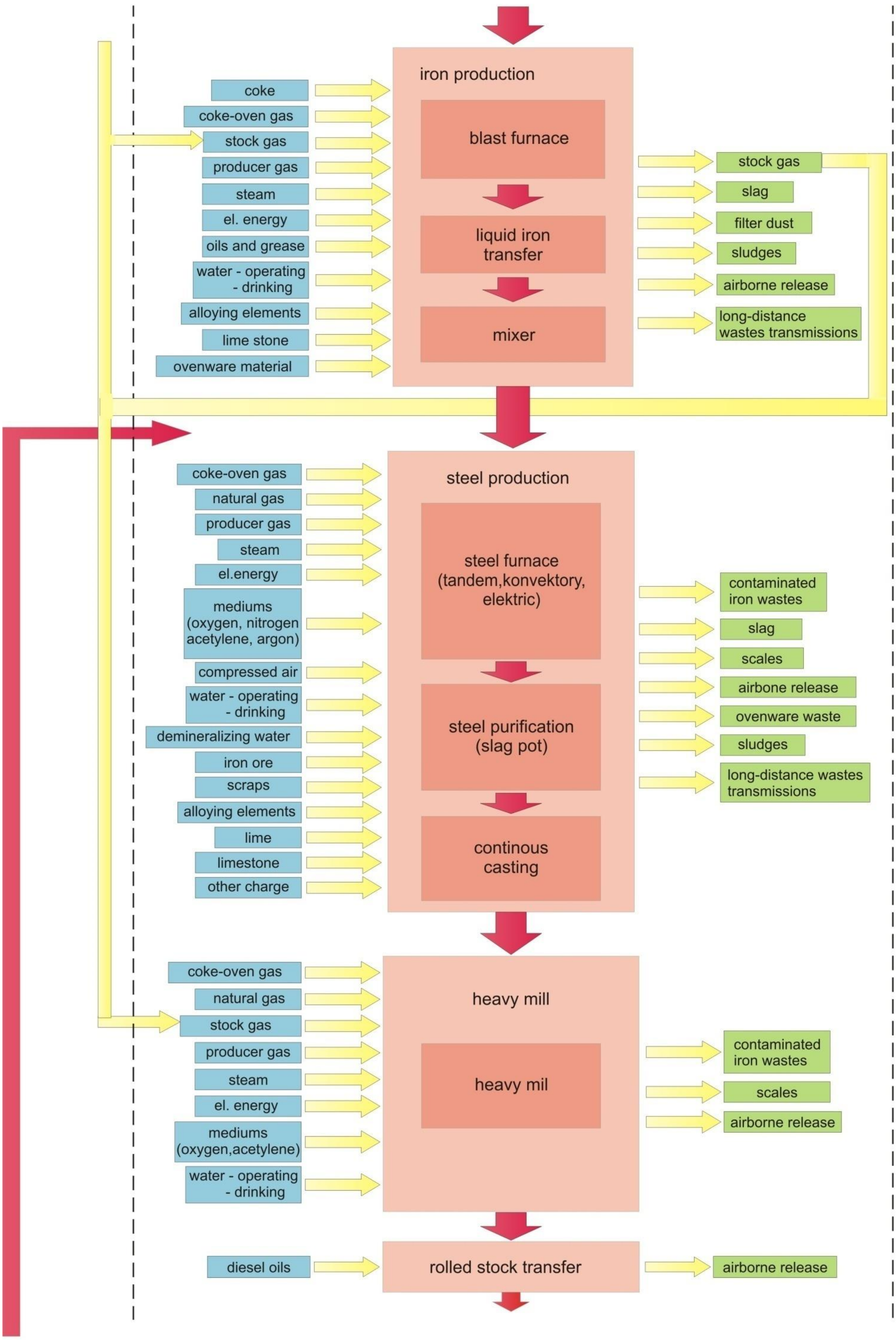
- electric energy and thermal energy producing
- crude oil mining, transport and processing
- natural gas mining and transport
- black and brown coal mining and preparation
- uranium ore mining and preparation
- coke and coke-oven gas producing
- lime stone mining and lime producing
- mediums (oxygen, nitrogen, argon, compressed air, producer gas, acetylene and demineralized water) producing
- clay mining and ovenware producing
- aggregates (ferroalloys, calcium carbide) producing
- organic and inorganic materials producing

Descriptions of life cycle creating have detailed characterizing in author´s thesis. Main attention has been paid to life-cycle of fundamental materials (electric and thermal energy, crude oil, natural gas, black and brown coal). From information obtained by inventory analyze 2 inventory matrixes were created:

- inventory matrix of environmental impacts participation of particular stages of production
- inventory matrix of total environmental impacts of particular stages of production

In the first final matrix environmental impacts of particular stages of production were quantitatively appointed. In the second matrix there was made sum total of all impacts in particular stages, where impacts from all previous stages are included. Results of the secondary matrix could apply very good in technical practice, because they give the summary of total impacts linked with producing in particular stages. There was created detailed graphic figure of life-cycle of steel structures too.




iron production
blast furnace
liquid iron transfer
mixer
coke
coke-oven gas
stock gas
producer gas
steam
el. energy
oils and grease
water - operating - drinking
alloying elements
lime stone
ovenware material
stock gas
slag
filter dust
sludges
airborne release
long-distance wastes transmissions
steel production
steel furnace (tandem,konvektory, elektric)
steel purification (slag pot)
continous casting
coke-oven gas
natural gas
producer gas
steam
el.energy
mediums (oxygen, nitrogen acetylene, argon)
compressed air
water - operating - drinking
demineralizing water
iron ore
scraps
alloying elements
lime
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slag
scales
airbone release
ovenware waste
sludges
long-distance wastes transmissions
heavy mill
heavy mil
coke-oven gas
natural gas
stock gas
producer gas
steam
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mediums (oxygen,acetylene)
water - operating - drinking
contaminated iron wastes
scales
airborne release
rolled stock transfer
diesel oils
airborne release

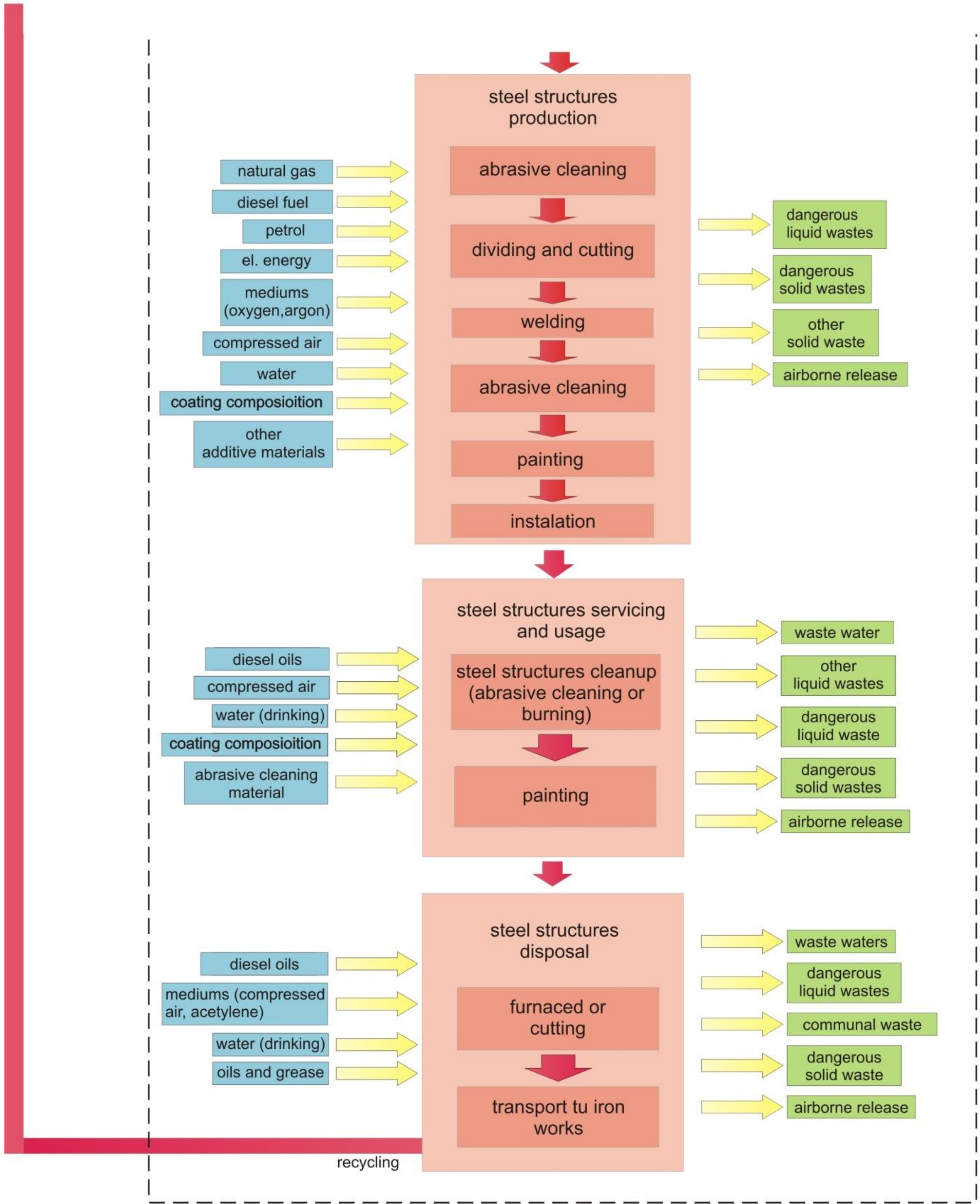


**Fig. 1: Detailed figure of life-cycle of steel structures**

In agreement with European legislative Life-cycle environmental impact analyses (LCIA) of steel structures were made. On the basis of the first matrix results have been assessing the following primary environmental impacts:
mineral raw material and water consumption

- waste production
- contributing to climate changes owing to radiation-active gases emissions (so-called greenhouse effect)
- contributing to origin of acid dry and wet atmospheric depositions (so-called acid rain)
- contributing to water eutrophization
- contributing to increases in environmental toxicity (air toxicity, which damage human health, and toxicity of water environment)

During the 1t steel structural production is used:

- 4,06 t mineral raw materials (black coal, brown coal, crude oil, matural gas, uranium ore, lime, clay, iron ore, other ores, other raw materials)

- 70,790 t water and is produced 20,298 t waste water

During the 1t steel structural production is produced:
6,935 t wastes (was valued 3 fundamental groups: inert, dangerous and other wastes)

- 3,806 t greenhouse gases (CO2, methane, hydrochlorofluorohydrocarbons), which was aggregated through the CO2- equivalent
- 9,596 kg gases, which are conducive to acid rains (nitrogen oxides, sulfur oxides and ammonia), which was aggregated through the SO2- equivalent
- 1,705 kg matter, which are conducive to water eutrophization (total nitrogen and phosphorus, nitrogen oxides and nitrogen, which is bound to ammonia), which was aggregated through the PO4-3 - equivalent
- 19,296 kg matter, which are conducive to air toxicity (arsenic, benzene, benzopyrene, ammonia, chlorine, chrome, cadmium, copper, nickel, lead, mercury, vanadium, zinc, gauze), which is bound to ammonia), which was aggregated through the Pb - equivalent
- 19,296 kg matter, which are conducive to water toxicity (arsenic, chrome, cadmium, copper, nickel, lead, mercury, zinc), , which is bound to ammonia), which was aggregated through the PNEC- equivalent

During LCIA was detected that most of impact is the cause of energy production (electric and thermal energy). Those impacts were the cause of 2 processes:

- outright producing (energy-intensive consumption through particular stage producing)
- energy-intensive products consumption

Producing pollution was produced by iron and steel productions (by steel production has been producing the most of air toxicity, and iron production has been producing the most of greenhouse gases and acidification).
There was done data verification. The purpose of verification was done in order to control the information from producers (information, from which has been formed life-cycle of steel structures. The second level of verification was controlled by LCIA (results of LCIA were compared with comparable data from GEMIS database).

*Recommended for publication of Editorial board*

## Conclusion

There was done life-cycle of steel structures, which was done in Czech Republic, and its environmental impacts were considered. Within inventory analyzing from data of Czech iron and steel producer inventory matrix was formed. From inventory matrix quantification weighted environmental impacts were done (mineral raw material and water consumption, waste production, contributing to climate changes owing to radiation-active gases emissions (so-called greenhouse effect), contributing to origin of acid dry and wet atmospheric depositions (so-called acid rain), contributing to water eutrophization, contributing to increases in environmental toxicity). By obtained and calculated data verification was created.

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