

Czech University of Life Sciences Prague

**Faculty of Economics and Management
Department of Economics**



**ANALYSIS OF CO₂ EMISSIONS WITH FOCUS ON
TRANSPORTATION INDUSTRY**

Bachelor Thesis

Author: Daria Luchikhina

Supervisor: Assoc. Prof. Ing. Mansoor Maitah, Ph.D. et Ph.D.

Consultant: Ing. Oldřich Výlupek, MSc, Ph.D.

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Daria Luchikhina

Economics and Management

Thesis title

Analysis of CO2 emissions with focus on transportation industry

Objectives of thesis

The aim of the thesis will be to perform analysis of CO2 emissions with focus of transportation industry.

Methodology

The thesis will be divided to two parts theoretical part and practical part. The thesis will contain descriptive, comparative methods and logical inference methods.

The proposed extent of the thesis

35 – 50 pages

Keywords

CO2,transportation,EU target,emission,analyse

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Adéla Denková,2016, Emission from cars: EU wants clean air and climate safety. Both effort however, not complement.

Dave Jones,Mara Marthe Kleiner,2016, Energy transition in the power sector in Europe: State of Affairs in 2016.

McKinsey&Company, 2016, Costs and potential reductions of greenhouse gas emissions in the Czech Republic,pp. 27-33.

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The Bachelor Thesis Supervisor

doc. Ing. Mansoor Maitah, Ph.D. et Ph.D.

Supervising department

Department of Economics

Advisor of thesis

Ing. Oldřich Výlupek, MSc, Ph.D.

Electronic approval: 13. 3. 2017

prof. Ing. Miroslav Svatoš, CSc.

Head of department

Electronic approval: 13. 3. 2017

Ing. Martin Pelikán, Ph.D.

Dean

Prague on 13. 03. 2017

Declaration

I declare that I have worked on my diploma thesis " ANALYSIS OF CO₂ EMISSIONS WITH FOCUS ON TRANSPORTATION INDUSTRY" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague, March 5, 2017

.....

Daria Luchikhina

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Summary
ANALYSIS OF CO₂ EMISSIONS WITH FOCUS ON TRANSPORTATION INDUSTRY

ANALÝZA EMISÍ CO₂ SE ZAMĚŘENÍM NA DOPRAVNÍ PRŮMYSL

Air pollution is a problem bounded with many different pollutants. One of a branch of air pollution is from transportation. Although substantial and well-targeted actions have led to decreasing of the reduction emission in Europe to pose a risk and have an adverse impact on human health and on the natural and built environment.

In the theoretical part contains from 3 blocks which are describe what is air pollution, sources of pollution. Mostly thesis focused on pollution impact from CO₂. Also on the thesis, describe ecological situation in the world focused to Europe.

The thesis is devoted to CO₂ pollution from transportation. The thesis focused on comparing level to emission and ways of the solution in the Czech Republic. On better understanding situation also analyzed main areas of influence of air pollution from CO₂. The result of the thesis is found a decision for improving the situation in the Czech Republic, a foundation to Swiss experience to decreasing amount of CO₂ from transportation.

Key words: CO₂, transportation, EU target, emission, analyse

Summary

ANALYSIS OF CO₂ EMISSIONS WITH FOCUS ON TRANSPORTATION INDUSTRY

ANALÝZA EMISÍ CO₂ SE ZAMĚŘENÍM NA DOPRAVNÍ PRŮMYSL

Znečištění ovzduší je problém ohraničené s mnoha různými znečišťujícími látkami. Jeden z pobočky znečištění ovzduší pochází z dopravy. Ačkoli značné a dobře cílených opatření vedou k snížení na snižování emisí v Evropě představovat nebezpečí a mít nepříznivý dopad či lidské zdraví a na přírodní a zastavěného prostředí.

Teoretická část bakalarské práce obsahuje 3 bloků, které jsou popsány, co je znečištění ovzduší, zdroje znečištění. Většinou práce zaměřena na dopady znečištění z CO₂. Také na práci, popsat ekologické situace ve světě zaměřený na Evropu.

Ve praktické části tato práce je věnována znečištění CO₂ z dopravy. Práce se zaměřila na úrovni se porovnání emisí a způsoby řešení v České republice. Na lepšímu pochopení situace rovněž analyzovala hlavní oblasti vlivu znečištění ovzduší z CO₂. Výsledek práce je našel rozhodnutí pro zlepšení situace v České republice, nadace Švýcarské zkušeností snížení množství CO₂ z dopravy.

Klíčová slova: CO₂, doprava, cíl EU, emise, analýza

Table of content

1.	List of abbreviations.....	10
2.	Introduction.....	11
3.	Objectives.....	12
4.	Literature review	13
4.1.	What is air pollution?.....	13
4.1.4.	Why CO ₂ is problem?.....	14
4.1.5.	Types of air pollution.....	14
4.1.6.	Causes of air pollution	15
4.1.7.	Development prospects of air pollution.....	17
4.2.	Environmental impact from transport	18
4.2.1.	The main pollutants from transport	19
4.3.	Emission in EU	21
4.3.1.	Transport situation in Europe nowadays	21
4.3.2.	Kyoto protocol in Europe	22
4.3.3.	CO ₂ emissions in analysed countries	23
4.4.4.	Emission allowances in 2016.....	23
5.	Methodology	25
6.	Result	26
6.1.	Basic information about countries	26
6.1.1.	Czech Republic.....	26
6.1.2.	Switzerland	28
6.2.	Emission of CO ₂ from fuel combustion	30
6.2.1.	Czech Republic.....	30
6.2.2.	Switzerland	31
6.3.	Emission of CO ₂ from transportation.....	33
6.3.1.	Czech Republic.....	33
6.3.2.	Switzerland	35
6.4.	Emission of CO ₂ from energy industry	37
6.4.1.	Czech Republic.....	37
6.4.2.	Switzerland	38

6.5.	Emission of CO ₂ from construction and manufacturing industries.....	39
6.5.1.	Czech Republic.....	39
6.5.2.	Switzerland.....	40
6.6.	Emission of CO ₂ from agriculture.....	42
6.6.1.	Czech Republic.....	42
6.6.2.	Switzerland.....	42
6.7.	Emission of CO ₂ in households.....	44
6.7.1.	Czech Republic.....	44
6.7.2.	Switzerland.....	44
7.	Conclusion.....	46
8.	References:.....	48

1. List of abbreviations

CEF-conserve-energy-future.com	• (Centrum dopravního výzkumu, veřejná výzkumná instituce)
UT-univvercetoday.com	
CO-Carbon oxide	ČHMÚ-
CO ₂ -Carbone dioxide	• Czech Hydro Meteorological Institute
SO ₂ - Sulphur dioxide	• (Český hydrometeorologický ústav)
PHE-people.hofstra.edu	
ACEA-European Automobile Manufacturers Association	CS- www.celysvet.cz
EU- European Union	BAC-www.bfe.admin.ch
ECE-ec.europa.eu	UNFCCC-United Nations Framework Convention on Climat Change
UI-unfccc.int	PE Act- The Act of the Protection of the Environment
MSR- Market Stabilization Reserve	FCO-Federal Statistical Office
TWh- terawatt-hours	SWI- swissinfo.cht
ETS- Emissions Trading System	SKF- www.skf.com
AS- autosap.cz	TI- tehnoinfo.ru
ZA- zpravy.actualne.cz	BCU- Binder Cement Underpants
N ₂ O-nitrous oxide	EIT- energyintime.eu
PM-particulate matter	CC- www.climatechangepost.com
PAH-polycyclic aromatic hydrocarbon	EEA- eea.europa.eu
NO _x - nitrogen oxides	CHF-Swiss franc code
IEA-International Energy Agency	ES-www.ecolosorse.ru
SOU- sandbag.org.uk	LNG- liquefied natural gas
VZ- vitejtenazemi.cz	D2- drive2.ru
WHO-World Health Organization	EEA Report- European Economic Area
LULUCF- land use, land-use change and forestry	LS- ladoshki.ch
CDV, v.v.i-	IPCC-Intergovernmental Panel on Climate Change
• Transport Research Centre, a public research institution	TSPUT-tspu.ru

GtC / year- gigaton of carbon per year

2. Introduction

Air pollution is transboundary ecological problem bounded with many different pollutants. Although substantial and well-targeted actions have led to decreasing of to the reduction emission in Europe to pose a risk and have an adverse impact or human health and on the natural and built environment. (EEA, 2016)

According to WHO data, the CO₂ emission is the reason for health problems on a global scale. More than 3, 7 million people are dying due to air pollution. Air pollution is the main reason of cancer (WHO, 2014).

One of a branch of air pollution is from transportation. This problem is globally important. In the city, transport is a source of warming air. For example, of simultaneously moving of 100 thousand cars is equal to production 1 mln. liters of hot water. Car exhausts gasses containing warm water vapor, contribute to the climate change in the Europe pollution from transportation. (EEA, 2016)

The thesis is devoted to CO₂ pollution from transportation. The thesis focused on comparing level to emission and ways of the solution in the Czech Republic and Switzerland. On better understanding situation also analyzed main areas of influence of air pollution from CO₂. The result of the thesis is found a decision for improving the situation in the Czech Republic, a foundation to Swiss experience to decreasing amount of CO₂ from transportation.

Switzerland was chosen because of the forefront in the question of decreasing greenhouse emission.

According to the research of Switzerland, possible to say the amount of CO₂ of transportation (31%) and industry (30%) big like in the Czech Republic. (Figure 24) Also the big influence of Switzerland from households. In Switzerland, more developed technologies for modernization and decreasing amount of pollution from households.

Energy as well has a big influence but in Switzerland more active using of nuclear energy in manufacturing. (Figure 21). The main reason of influence over transportation and manufacturing is economic dependence.

According to research, the biggest source of CO₂ in the Czech Republic is energy (Figure 18), that close connects with transportation area. Most energy sources are necessary for transportation activities. In addition, influential area for emissions is manufacturing. The reason of that economic dependence.

For the thesis, important that private cars are the majority of all of the types of cars in the Czech Republic (Figure 14). Europe has big positive experience in solving of this type of problems. That means we found some solution to decreasing amount of CO₂ from private transportation it could make some step for changing situation in the Czech Republic.

3. Objectives

The aim of the thesis is analyzed of CO₂ emissions of focus on the transportation industry.

To achieve this aim carries out a number of tasks:

1. Research information about air pollution with focus on transportation area;
2. Compare main areas of pollution in Czech Republic and Switzerland;
3. Based on Switzerland experience to propose options of solution to the Czech Republic;

4. Literature review

4.1. What is air pollution?

Now air pollution is one of the actual problems what we can hear. We hear about some types of pollution. One of the dangerous effects of this pollution is you cannot save from this effect of indoors or outside. A physical, biological or chemical alteration to the air in the atmosphere can be termed as pollution. It can happen, when any smoke, fog, harmful gasses enter into the atmosphere and makes air difficult for plants, animals, and humans for normal existence. (CEF,2016)

Under the pollution refers to the process of bringing in the air or the formation of physical agents, chemical substances or organisms, adversely affecting the living environment or causing damage to property. In a sense, it can be considered pollution and removal of air separate gas components (such as oxygen) major technological objects, the process is depended upon road transport. The pollutants and toxic substances transported over long distances with precipitation fall into the soil, surface water and groundwater, the oceans, poisoning the environment, negatively affects obtaining of vegetable biomass and included in the cycles of many elements of the biosphere. The circulation of atmospheric flows affects the local climate conditions, and through them - in the regime of rivers, soil and vegetation and relief formation process. In a sense, it can be considered pollution and removal of air separate gas components (such as oxygen) major technological objects, the process is depended upon road transport. Despite the fact that the weight of the outer shell of the biosphere (the atmosphere) is negligible compared to the mass of the planet, its role in all natural processes is huge. Around the globe, the atmosphere determines the overall thermal regime of the Earth surface. In addition, the gas composition contains a variety of substances released by natural and man-made sources, such as dust, having vegetable, volcanic, space, soil and anthropogenic origin; liquid droplet water (fog); particles of sea salt; gases generated during forest and steppe fires; various products of vegetable, animal or microbiological origin. (ES, 2016)

From the composition, Earth is containing from the gasses like nitrogen (78%), oxygen (21%), and other gasses (like argon and carbon dioxide). This balance is so important to surviving on a planet, that introduction harmful substances can influence profound and damaging effect. Pollution of the atmosphere can adopt to some forms like carbon compounds:

carbon monoxide (CO) and carbon dioxide (CO₂). Sulfur compounds such as sulfur dioxide (SO₂), methane, radioactive decay, or toxic chemicals. (UT, 2016)

4.1.4. Why is CO₂ problem?

CO₂ is a greenhouse gas, which retains a part of the solar radiation thereby causing heating of the earth's surface. Carbon dioxide (CO₂) emitted into the atmosphere compared with the 19th century dramatically increased. The main reason is the ever-increasing consumption of fossil fuels (oil, natural gas and coal) industry, transport, and households. Fossil fuels contain carbon - by their combustion to CO₂ and then shapes the smoke rising from factory chimneys, boilers, mufflers of motor vehicles into the atmosphere. (Geology, 2016)

Unless rapid action taken to reduce radically CO₂ emissions will rise by analyses of the IPCC, an international panel of experts on climate change, by 2100 the average temperature at the Earth's surface by 2.4 ° C to 6.4 ° C. Already an increase in 2 ° C considered being for a change, which would be for humanity and the environment could have critical consequences. To avoid exceeding this limit, it is necessary at least until 2050 to reduce global CO₂ emissions by at least 50%. (Geology, 2016)

4.1.5. Types of air pollution

Air pollution mixed from a natural and human-made substance in the atmosphere, which we are breathing. It is typically separate two categories: pollution of the atmosphere and indoor air pollution. (Niechs.nih, 2016)

Outdoor air pollution involves causes, which happened outside of building environment.

Examples include:

- Small pieces produced from burning fossil fuels (like coal and petroleum which uses on traffic and energy production)
- Harmful gasses (sulfur dioxide, nitrogen oxides, carbon monoxide, chemical vapor, etc.)
- Ground-level ozone (a reactive form of oxygen and a primary component of urban smog)
- Tobacco smoke

Indoor air pollution includes influence on particulates carbon oxides, and other pollutants indoor air or dust. (Niechs.nih, 2016)

- Gasses (carbon monoxide, radon, etc.)
- Household products and chemicals
- Building materials (asbestos, formaldehyde, lead, etc.)
- Outdoor indoor allergens (cockroach and mouse dropping, etc.)
- Tobacco smoke
- Mold and pollen (Niechs.nih,2016)

4.1.6. Causes of air pollution

Closely link human to the environmental origin, material, and spiritual needs. The scope and form of these bonds rises steadily from the local use of certain natural resources to virtually full involvement in the resource potential for the planet's life supports in a modern industrialized society. (TSPUT,2016)

With the emergence of human civilization, a new factor affecting the state of the biosphere. He achieved immense power in this century, especially in recent decades. The scale of its impact on the nature of the 6 billion of our contemporaries are about 60 billion people of the Stone Age, and the amount of energy released by man may soon become comparable to the energy received by the Earth from the sun. Man, developing production, remaking nature, adapts it to its needs, and the higher level of production, the more perfects the technique and technology, the greater the degree of use of the forces of nature and environmental pollution. (TSPUT,2016)

Air pollution is the result of natural and human factors. Examples of natural aspects are results of abrupt changes of temperature, seasonal changes, and regular cycles. Pollution from natural reasons is not very often. (Eschooltoday, 2016)

4.1.6.1. Human factors include:

4.1.6.1.1. Unintentional changes

This pollution, changes from the gas composition of the atmosphere, climate change, acid rain, accelerate corrosion of metals, the formation of photochemical fog (smog), violation of the ozone layer, the development of erosion, desert encroachment. Environmental disasters

because of major accidents, depletion of the species composition of ecological communities, the development of environmental diseases in the population, and others. (TSPUT,2016)

Unintentional environmental changes come to the fore, not only many of them are very significant and important, but also they are less supervised and are fraught with unpredictable effects. In addition, some of them, such as man-made CO emission or thermal pollution, essentially inevitable, and elimination of other requires huge costs. (TSPUT,2016)

4.1.6.1.2. Deliberate transformation

Be the development of land for crops or perennial plants, construction of reservoirs canals and irrigation systems, the construction of cities, industries and railways, digging mines, pits, mines and drilling for mining, draining of wetlands, etc. (TSPUT,2016)

4.1.6.1.3. Emissions from manufacture activities

Plants for burning waste, manufacturing industries, and power plants isolated high levels of carbon monoxide, organic compounds, and chemicals into the atmosphere. It happens where living people. Petroleum industry also exhalation hydrocarbons to the air. (Eschooltoday, 2016)

4.1.6.1.4. Burning fossil fuel

Cars, heavy duty trucks, trains, planes are burning a lot of fossil fuel to work. Emissions of transportation activities contain primary and secondary pollutants. That is one of the main reason of pollution of the environment. This factor is difficult to manage. The reason of that necessary of transportation for people and goods and for them. (Eschooltoday, 2016)

Fumes from cars contain harmful gasses like carbon monoxide, oxides of nitrogen, hydrocarbons, and particulates. Influence of these gasses is harmful to breathing; also, they are reaching for creation new gasses. (Eschooltoday, 2016)

4.1.6.1.5. Households chemical pollution

Household cleaning products, insect repellents, smoke from tobacco products are polluting the air inside of the house. (Eschooltoday, 2016)

The most important forms of human impact on the environment include over-exploitation and depletion of natural resources and the man-made pollution. (TSPUT, 2016)

4.1.7. Development prospects of air pollution

The use of natural resources will increase dramatically from the next 50 years. It is expected that the population of the planet would increase by that time by 60%. (TSPUT, 2016)

Anthropogenic pollution of various natural environments has a very negative impact on living organisms, the human condition, and his health. Anthropogenic pollution in recent decades has become a global nature, which led to a sharp deterioration of the natural ecosystems and significantly reduced operational resources available on Earth. In addition, various types of man-made pollution are the cause of many environmental problems of our time (ozone screen, climate change, waste problems, loss of biodiversity). (TSPUT, 2016)

Human impacts on the environment in the modern age have been a factor of geological or cosmic scale, surpassing all the natural forces that have ever influenced the evolution of life, the evolution of the Earth's biosphere. (TSPUT, 2016)

Today there is a deviation from the equilibrium of the carbon cycle pre-industrial state. If at the end of the last century still going increase the biological productivity and biomass in response to the increase in carbon dioxide concentrations in the atmosphere since the beginning of this century, this phenomenon is not found. Conversely, biota emits carbon dioxide and is therefore automatically reduced biomass. (In the land biota is a reduction of mass of organic carbon at a rate of 1.1 GtC / yr. Biota Ocean absorbs organic carbon at a rate of 2.3 GtC / yr.) (TSPUT, 2016)

4.2. Environmental impact from transport

Road transport is one of the main sources of air pollution. The share of transport in total emissions of pollutants in urban areas can be up to 60-80%. More than 80% of the emissions comprise carbon oxides, sulfur dioxide, nitrogen, hydrocarbons, and solids. From gaseous pollutants emitted in the largest quantities of carbon oxides, carbon dioxide, carbon monoxide, mainly formed by combustion. In large quantities of the atmosphere and the oxides of sulfur: sulfur dioxide, sulfur dioxide, carbon disulfide, hydrogen sulfide and others. The most numerous class of substances that pollute the air of large cities are hydrocarbons. Among the ingredients of the gas constant of air pollution are also free chlorine and its compounds other. (ES, 2016)

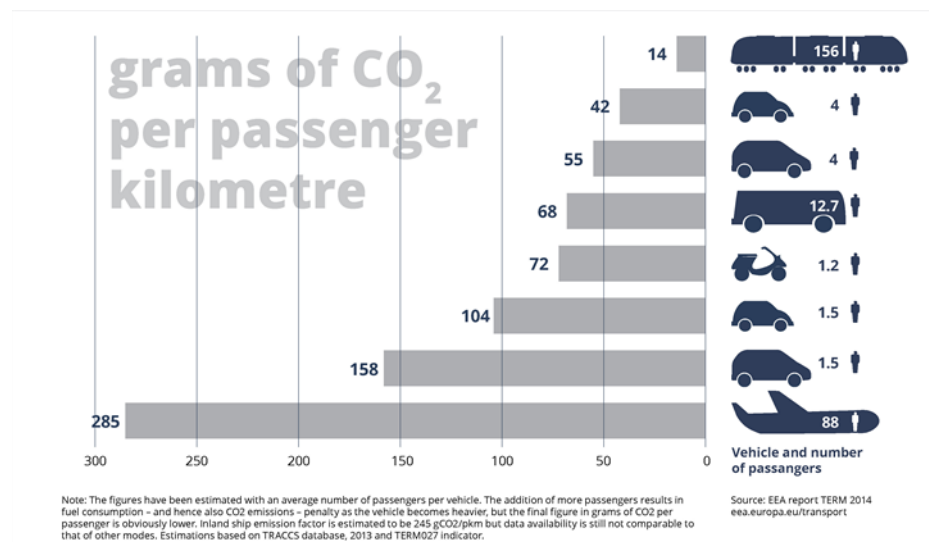


Figure 1.

CO₂ emissions from passenger transport, 2016

Source: EEA Report

Question about transportation and environment is paradoxical, because we are needing a transport for social and economic purposes. At the same time transport, provide a negative impact on the environment. From one side, transportation company supports increasing needs of mobility for passengers and goods. From another side, transport activities connect with increasing level from ecological factors. The increase of private and cargo activities on last 10 years expanding the role of transport like the source of harmful matter with plentiful impact to the environment. (PHE, 2016)

We can divide into 3 sections:

4.2.1.1. Direct impact

Some points of direct impact are clear. We can attribute to them level of noise, carbon monoxide emission. (PHE, 2016)

4.2.1.2. Indirect impacts

This type of impacts is not so clear about finding and understanding the interrelation between reason and result of the environmental impact. For example, particulates are the result of not completely burning on the engine are the indirect reason for cardiovascular diseases they influence another factor. (PHE, 2016)

4.2.1.3. Cumulative impact

This impact on effect transports activity cause of combined results from past, present and future aspects. This indirect impact group of environmental factors. The indirect reason for climate changing is the aggregate impact on several natures and human factors. One of them is transport 15 % of global CO₂ emissions occur to transport sector. (PHE, 2016)

4.2.1. The main pollutants from transport

Because of environmental pollution with the exhaust, gasses of internal combustion engines of ecological disaster area by harmful substances for the population are especially large cities. The problem further reduces harmful engine emissions all the acute in view of the continuous increase in the fleet operated vehicles, motor to seal to flow volatility indicators themselves of measures to reduce harmful substances during operation. The main share of the damage caused by motor vehicles (78%) associated with air pollution emissions, 16% of the damage falls on the effects of the noise impact of transport on the population. (Korobkin, 2006)

The principle of operation of automobile engines based on the conversion to chemical energy of liquid and gaseous fuels of petroleum origin into heat, and then - into mechanical energy. Liquid fuel mainly composed of hydrocarbon gasses along with the hydrocarbons contain incombustible gasses such as nitrogen and carbon dioxide. During the combustion of fuel to the engine, cylinders are formed into non-toxic (water vapor, carbon dioxide) and toxic sub-

stance. The latter is the products of combustion or adverse reactions that occur at high temperatures. These include carbon monoxide CO, hydrocarbons CmHn, nitrogen oxides (NO and NO₂) commonly referred to NO_x. In addition to these substances, harmful effects on the human body have allocated when the engines lead compounds, carcinogens, soot, and aldehydes. (Korobkin, 2006)

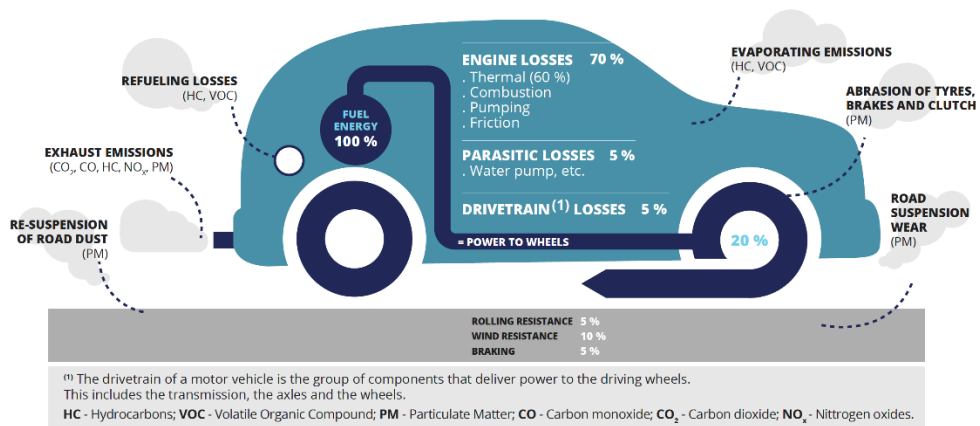


Figure 2.
Vehicle emissions and efficiency, 2016

Source: EEA Report

The main toxic components of exhaust gasses generated during operation of gasoline engines is carbon monoxide. It is formed by the oxidation of fuel carbon incomplete due to lack of oxygen in the whole volume of the engine cylinder or in separate parts. (Korobkin,2006)

The main source of toxic substances released during operation of diesel engines, the exhaust gasses are. Diesel crankcase gasses contain significantly fewer hydrocarbons than gasoline engine due to the fact that in diesel clean compressed air, and broken through in the expansion process gasses contain a few hydrocarbon compounds that are a source of atmospheric pollution. (Korobkin,2006)

4.3. Emission in EU

According to new analysis emission from *Sandbag and Agora Energiewende* power emission fell by 4, 5% in 2016. One of the most important reason was partial switchover from coal to gas firing. Energy production from are decreasing to 94 TWh, but production from gas oppositely increasing to 101 TWh. That change means annual decreasing CO₂ emission to 40 mln. tones. (SOU,2016)

The main source of decreasing to half of this emission was closing number of coal manufacturers in the UK. This result achieves due to increasing amount of fee on carbon increasing. Local coal production was switch coal to gas. This switching occurs in countries like Italy, Greece, Netherlands, and Germany. (SOU,2016)

Gas has not reached own record production like in 2010(168 TWh) and we cannot wait for the next significant changes. On a failing EU Emissions Trading System, the structural surplus has passed 3 billion tons of CO₂. (SOU,2016)

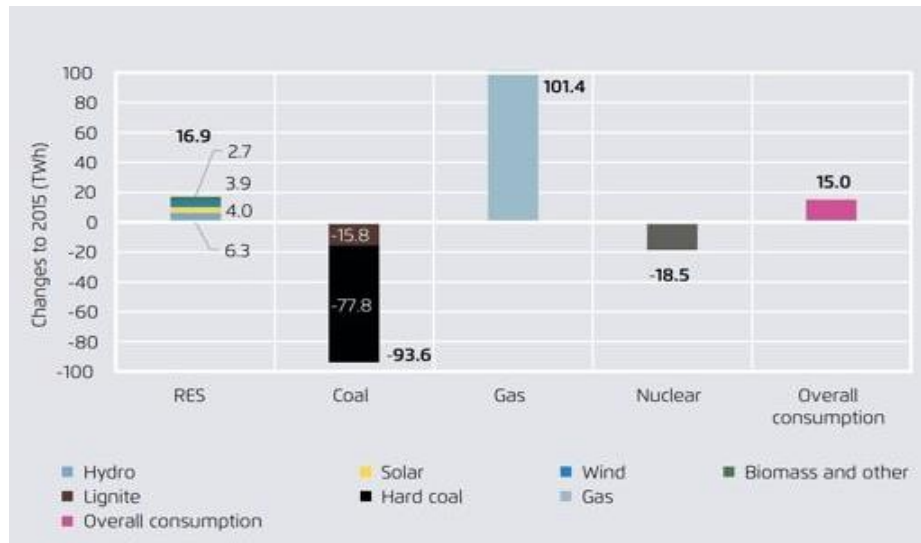


Figure 3.

Changes in gross electricity generation and consumption in European Union 2015 to 2016,2016

Source: Sandbag and Agora Energiewende

4.3.1. Transport situation in Europe nowadays

According to ACEA (European Automobile Manufacturers Association), research emission from transportation increase from the last 20 years to 34%. In EU, for example, cars worth

12 % from all of emission CO₂, which is the main greenhouse gas. (Emission from cars, Denkova, 2016)

Ecological organization reminds that CO₂ emissions on the real life are increasing the difference between studies. Actually, cars consume more fuel, which means a higher production of carbon dioxide. (Emission from cars, Denkova, 2016)

Pursuant to the automakers resulting of emission depends on not only on car, but also, for example, the condition of roads and driver behavior. We can save or increase the amount of pollution by technology which using in cars and remember about the necessity to protect the environment. (Emission from cars, Denkova, 2016)

"The automotive industry is ready to European policy makers to explore how to combine climate protection policy and higher standards for air quality," he said at the end of October 2016, the Secretary General of ACEA Erik Jonnaert. (Emission from cars, Denkova, 2016)

4.3.2. Kyoto protocol in Europe

Kyoto protocol is international agreement untied with United Nations Framework Convention on Climate Change, which unites Parties of the protocol on international level follow the target of emission. (ECE, 2016)

Mainly, developed countries responsible for a high level of greenhouse emissions in the atmosphere as a result of 150 years of active industrial activity. The protocol takes more responsibility to high-developed countries according to the principle "common but differentiated responsibilities." (ECE, 2016)

The Kyoto protocol adopted in Kyoto, Japan, on 11 December 1997 and entered into force 16.02.2005. More details on Kyoto protocol improved in Marrakesh, Morocco, in 2001 and called "Marrakesh Accords". The first part of this protocol contains 2008-2012. (UI, 2016)

Now we can talk about the result of the first part of this agreement in EU. The Commission's annual progress report on EU greenhouse gas emissions says that 15 countries EU overachieved agreement of Kyoto protocol for the first period. (UI, 2016)

Connie Hedegaard, European Commissioner for Climate Action, said: "The EU is clearly delivering on its Kyoto commitments. The EU has reduced its emissions significantly since 1990 while expanding its economy. This further demonstrates that climate policy can

implement in a way that fosters jobs and growth. Our 20% reduction target for 2020 is also within reach thanks to our climate and energy legislation. And through additional policies, we're actually on track to overachieve our target." (UI, 2016)

For the second period (2013-20) EU wants to achieve average decreasing of emissions to 20% a basic year (1990) during the time of the second period together with Iceland. (ECE, 2016)

4.3.3. CO₂ emissions in analyzed countries

According to data of The World Bank, we can see that emissions of CO₂ in the Czech Republic are equal to 9,383 metric tons per capita. We can compare this index with other countries in EU with close population and another factor for find some methods for decrease emission of CO₂ from transportation. In this thesis, country for comparing will be Switzerland (4.988 metric tons per capita).



Figure 4.

CO₂ emissions (metric tons per capita). Focus on the Czech Republic, 2016

Source: The World Bank

4.4.4. Emission allowances in 2016

EU addressing reform of its market for emissions trading. It gives the opportunity to evaporate more emissions in the atmosphere. The government of some EU countries completed the free allocation of emission allowances. France proposed a price corridor for emission allowances. Verified emissions in the EU ETS fell by 7.3 million tons (- 0.39%). (EurActiv emission allowances, 2017)

Aim of ETS is stimulation of decreasing emission according to creation of limit and trade with allowances, called „cap-and-trade system“(Potential of decreasing greenhouse gasses in Czech Republic, McKinsey, 2017)

The French Government in March suggested that if the price of emission allowances falls below a defined level, the government canceled the auction and allowances will be moved to market stabilization reserve (MSR). The European Commission immediately rejected the French proposal. (EurActiv emission allowances, 2017)

EU Court ordered the European Commission to recalculate the free allocation of emission allowances and develop a stringent methodology for the free allocation. Among the main points included the revision of the linear reduction factor in 2023, the introduction of four-free allocation of emission allowances, trying to avoid the use of cross-sectoral correction factor, reduced threshold for withdrawal from the ETS to 50,000 tons of CO₂ per year and finish dates for surrendering allowances. (EurActiv emission allowances, 2017)

Draft regulations for the reduction of non-ETS emissions permit cancellation of ETS allowances July 20 Commission presented a proposal for a regulation on emissions reductions in sectors outside the EU ETS for the period 2021 to 2030. The objectives vary from 0% in Bulgaria, 40% reduction for Sweden and Luxembourg. All Member States will be able to use credits granted for afforestation (to a total limit of 280 million), but only 9 countries will be able to cancel 100 million ETS emission allowances to compensate for emissions in sectors outside the EU ETS. (EurActiv emission allowances, 2017)

International Civil Aviation Organization signed an agreement to offset emissions from international aviation. Measures called CORIS (Carbon Reduction and Offsetting Scheme for International Aviation) includes a global scheme to offset emissions to compensate for the rise in CO₂ emissions. (EurActiv emission allowances, 2017)

The ENVI Committee adopted a draft reform of the EU ETS, which allows for greater linear reduction factor (2.4%), higher volume of allowances that can download to MSR (24% of the surplus each year during the first four years of operation MSR) and not 800 million allowances in 2021. Member States have not yet been able to reform a common position against the deal. The European Parliament should be a revision of the EU ETS vote in February. The discussion could then begin in the spring. (EurActiv emission allowances, 2017)

5. Methodology

The thesis will contain descriptive, comparative and logical inference methods. In thesis compared amount of CO₂ in the main areas of pollution with help oEnergetice.cz, The World Bank, FSO, IEA, CDV, v.v.i., CHMU, UNFCCC. Although according to research Switzerland experience, find problems and possible solutions suitable for the Czech Republic.

6. Result

6.1. Basic information about countries

6.1.1. Czech Republic

The Czech Republic is located in Central Europe between four countries. To the west is Germany; in the northeast is Poland, in the southeast of Slovakia and a southern border with Austria. Area of Czech Republic is 78 866 km². The population of the country is 10 553 843 (actual for 1.01.2016). (Zemepis, 2017)

The Czech Republic is decreasing of energy independent to brown coal, which had a negative influence to live quality on Northern Bohemia. The biggest energy source is Nuclear power plant Temelín (14% manufacturing of electricity in the Czech Republic), the next Nuclear power plant located in Dukovany. The Czech Republic is one of the biggest current exporters in the Europe, on 2013 exported about 17 TWh, most of that produced on Temelín. (ZA, 2017)

According to data CRV / SDA 30.09.2016 in the Czech Republic registered 7 069 206 units motor vehicles of all categories. Increasing of average age motor vehicles all of the categories except buses. (AS, 2017)

According to „The Economist“, since the 1990 year, pollution from greenhouse gasses (Mainly CO₂), emission Czech Republic decrease to 30%, but also this index is higher on 8% by Kyoto protocol. Czech Republic has one of the highest levels of emission from reach country group of the OECD (the aim of organization-improve economic and social level of people around the world). One of the most important reason is coal, which emissions contain high amount of carbon. (AS, 2017)

On another side, Czech Republic, use nuclear energy. That explain good index according to Kyoto protocol despite to availability coal manufacturers older than 50 years. (The Economist, 2016)

The result of the process you can see on Figure 5.



Figure 5.

Total emission of CO₂ in the Czech Republic, 2013

Source: oEnergetice.cz

Compare with another country in the world, Czech Republic is producing a small amount of greenhouse gasses, but on converting to population is one of the biggest element. That difference exists because of high production to GDP, reduced but still high level of emissions. (The Economist, 2016)

Greenhouse gas emissions in electricity production and not always an efficient use of energy in various fields. (Potential of decreasing greenhouse gasses in Czech Republic, McKinsey, 2017)

We can analyze how different factors influence to amount of CO₂ in the atmosphere in the Czech Republic.

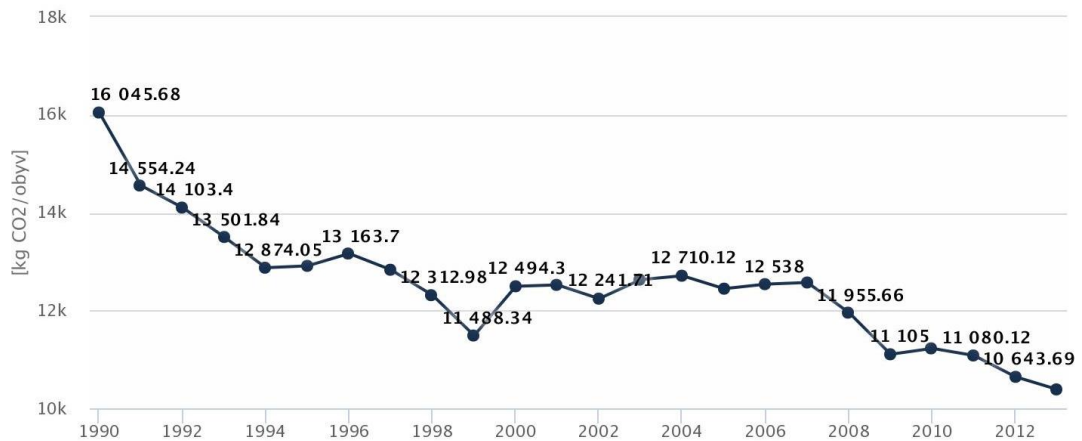


Figure 6.

Emission of CO2 in the Czech Republic per capita, 2013

Source: oEnergetice.cz

6.1.2. Switzerland

Switzerland is located in Western-Central Europe between five countries. Bordered to the east -France, to the north-Italy, Germany to the north, Austria and Liechtenstein to the east. Geographically located between the Alps, the Swiss Plateau, and the Jura. Area of Switzerland is 41 290 km². The population of country 8 401 120 (actual for 2016). The most influenced cities for economics are Zurich and Geneva. The capital of Switzerland is Bern (population 310 000). (CS, 2017)

Currently, 57% of the energy produced by hydroelectric and 40 % nuclear power plants, thereby Switzerland showed almost no CO₂ emissions. (Průmysl, 2016)

In the 2016 year were newly registered 414 986 cars. This index less to 2, 9% than the previous year. The largest group of newly registered vehicles was private cars. (FSO, 2017)

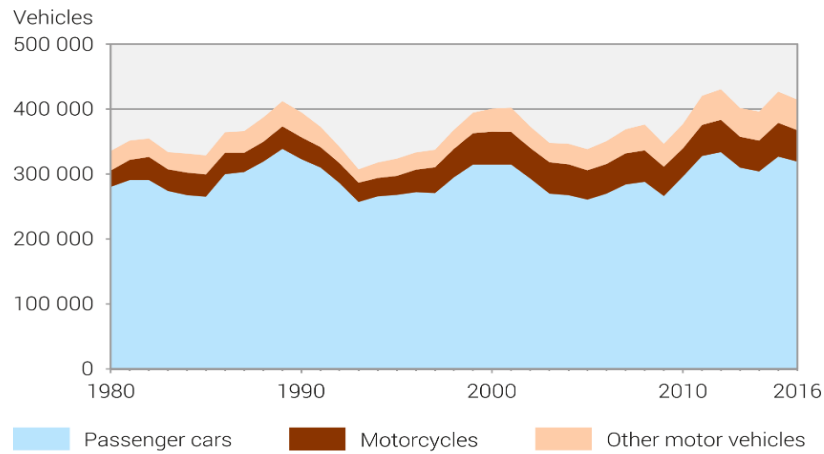


Figure 7.
New registrations of road motor vehicles in Switzerland, 2017
Source: FSO

Total CO₂ emissions mainly contains from anthropogenic sources (agricultural waste burning, forest fires, post-burn decay, peat fires and decay of drained peatlands) (IM, 2013)

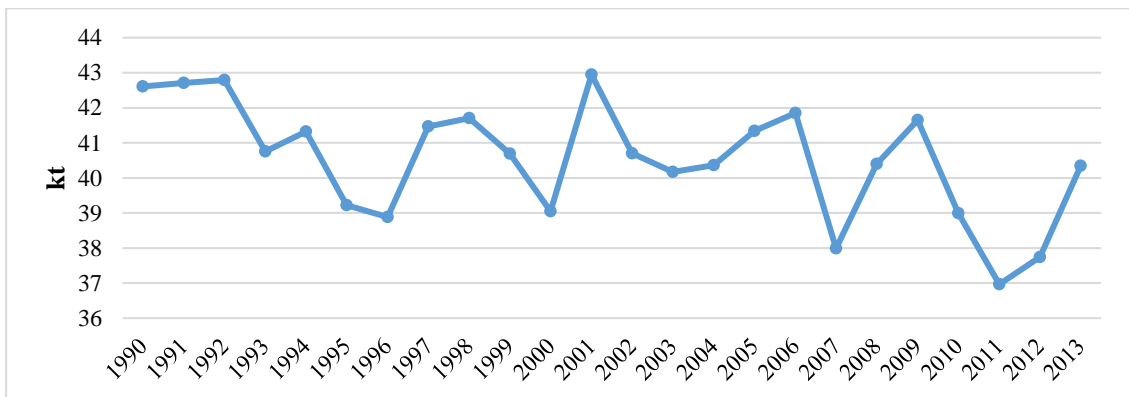


Figure 8.
Total CO₂ emissions in Switzerland, 2013
Source: The World Bank

Compared with the Czech Republic, Switzerland has the scope of changing on extremely lower amounts of pollutions per capita. (CZ, 10-16 metric tons per capita). The reason of that focus on this global problem and creating some local solutions.

For example, Swiss engineer Lisa Freden created a method for discharge valve stem seal in a diesel engine. It helps to decrease the volume of emission CO₂ in the atmosphere and save petrol. (SKF, 2017)

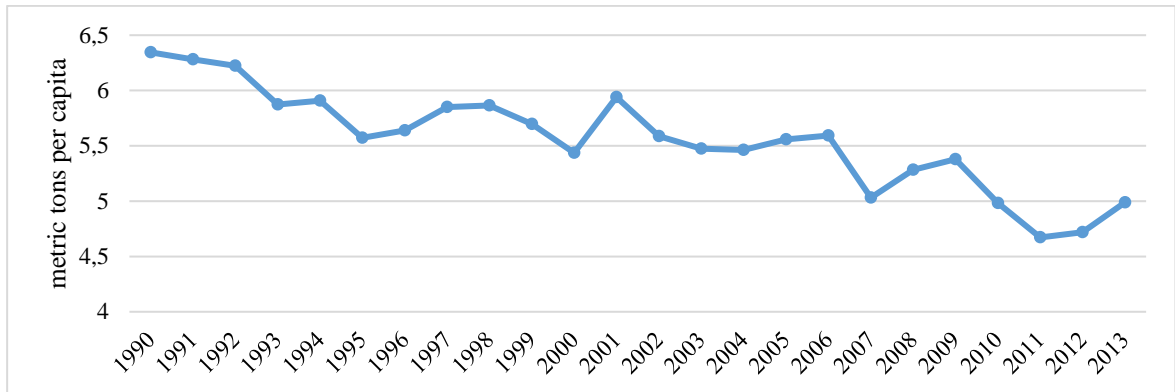


Figure 9.

Emission of CO₂ per capita Switzerland, 2013

Source: The World Bank

The aim of Switzerland reduce emissions of greenhouse gasses by 50% to 2030 years to 1990 levels. At least 30% must achieve on the domestic market. The foundation of Swiss environmental policy established in the 1985 year with The Act of the Protection of the Environment (SWI, 2016)

6.2. Emission of CO₂ from fuel combustion

6.2.1. Czech Republic

Combustion of fuels is a chemical process by which combine elements contained in the fuel with oxygen. In this process, heat released. Combustion quality depends on the correct proportions of fuel and oxygen, their mixing, further construction and technical status. (Schiedel, 2017)

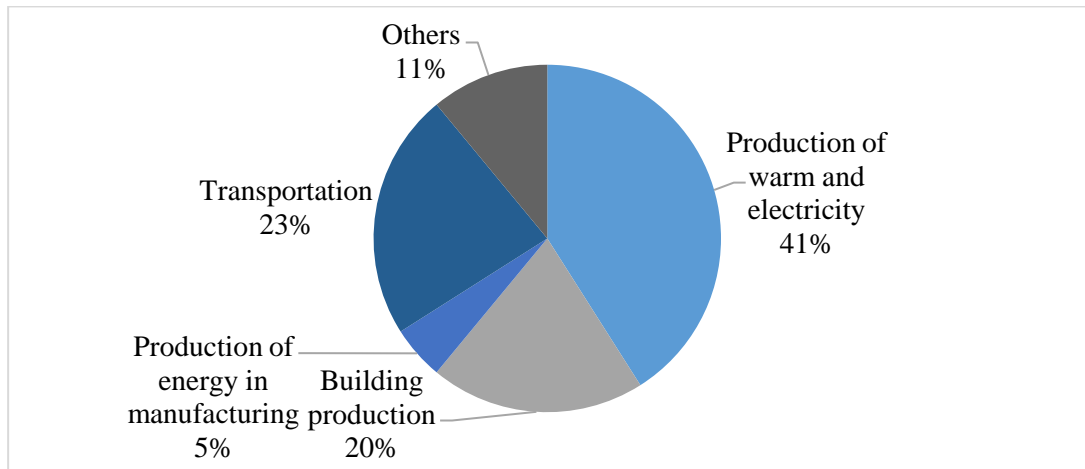


Figure 10.

Emission of CO₂ from fuel combustion by ways of using in the Czech Republic, 2015

Source: IEA

Fuel is one of a component of pollution from transportation. Figure 10 helps us to understand which part of emission goes from transportation. According to the graph below, we can see that the biggest influence has production of electricity and heat, the next factor is transportation.



Figure 11.

Emission of CO₂ from fuel combustion in the Czech Republic, 2013

Source: oEnergetice.cz

6.2.2. Switzerland

Switzerland depends on to Annex 1 Europe of Kyoto protocol. These countries complain obligations of Kyoto protocol to decreasing amount of CO₂. (TI,2016)

Switzerland government focus on the replacement of fossil fuels. One of an example of replacement can be plastic like safety and clear alternative fuel. Experiments in BCU tested positive and proved that 1 tonne previously prepared mixed plastic waste save 1,4 tons of coal. (TI,2016)

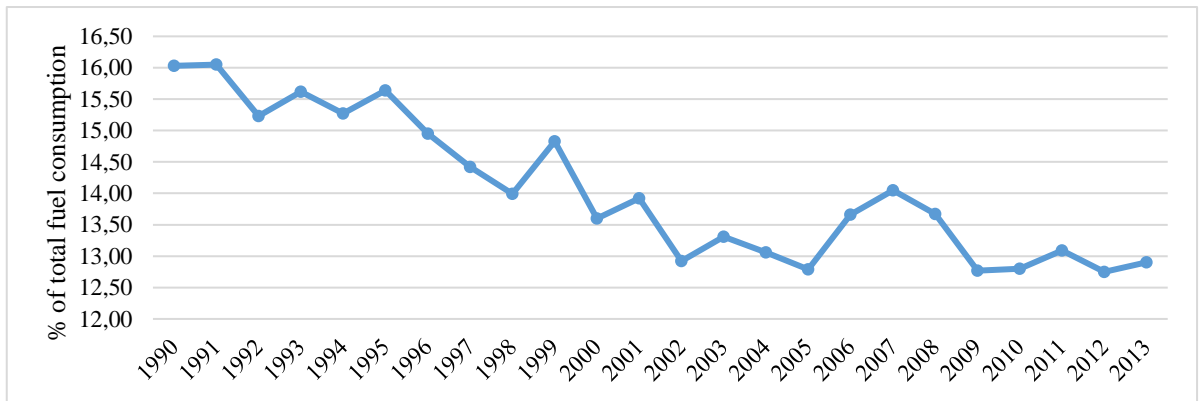


Figure 12.

Emission of CO₂ from fuel combustion in Switzerland, 2013

Source: IEA

6.3. Emission of CO₂ from transportation

6.3.1. Czech Republic

Transport is a major producer of greenhouse gasses and contributes to climate change. These cause, along with other substances, carbon dioxide (CO₂) and nitrous oxide (N₂O). During the construction of roads and other communications, traffic affects climate by cutting down forests that are capable of greenhouse gasses from the atmosphere to break down. (VZ, 2017)

The share of transport in total emissions of greenhouse gasses in the Czech Republic is around 13%. In fact, in the Czech Republic, the situation is worse than the European average. A smaller share of transport is due to greater production of greenhouse gasses from industry and the energy sector in the Czech Republic compared to the EU. (VZ, 2017)

Mostly greenhouse gas emissions (approximately 93%) in transport comes from road transport. It is because a number of emissions depends on the amount of fuel burned, and that greenhouse gasses cannot be deleted technologies to reduce emissions from vehicles. Unlike emissions of other pollutants (PM, PAH, NO_x) which has the largest share of road freight transport, producing the largest share of greenhouse gas emissions cars. (VZ, 2017)

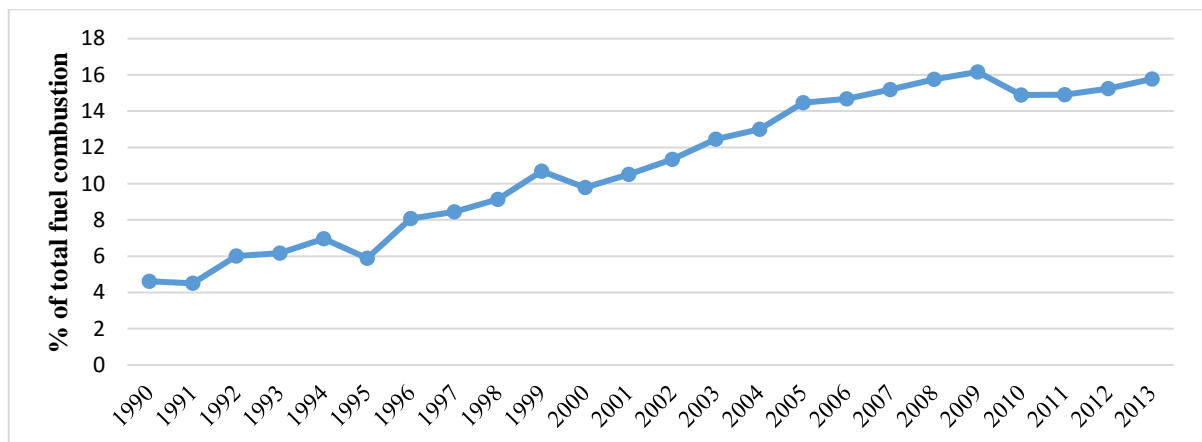


Figure 13.

Emission of CO₂ from transportation in the Czech Republic, 2013

Source: The World Bank

The average age of passenger cars in the Czech Republic in the first quarter of 2016 exceeded the limit of 15 years was 15.1 years. This highest rate since the beginning of the independent Czech Republic in 1993. At the end of 2015, the average age of cars in the Czech Republic was 14.3 years. According to the analyst Antonín Šípek, has long served as director of the Association of the automotive industry, the increase in the average age of cars in the Czech

Republic due to the fact that in the country there is no tool to motivate citizens to the elimination of old vehicles, which are unsuitable from the point of view of the environment and security. The negative influence of the increasing age and has the import of used cars. The most "old" category vehicles are motorcycles, their average age rose to 33.4 years. (Rozhlas,2016)

The one of the problem in transportation in the Czech Republic is increasing amount of car per capita due to economic growth. (Potential of decreasing greenhouse gasses in Czech Republic, McKinsey, 2017)

The second order is for road transport in the production of greenhouse gasses Airline share of rail and water transport is negligible. (VZ,2017)

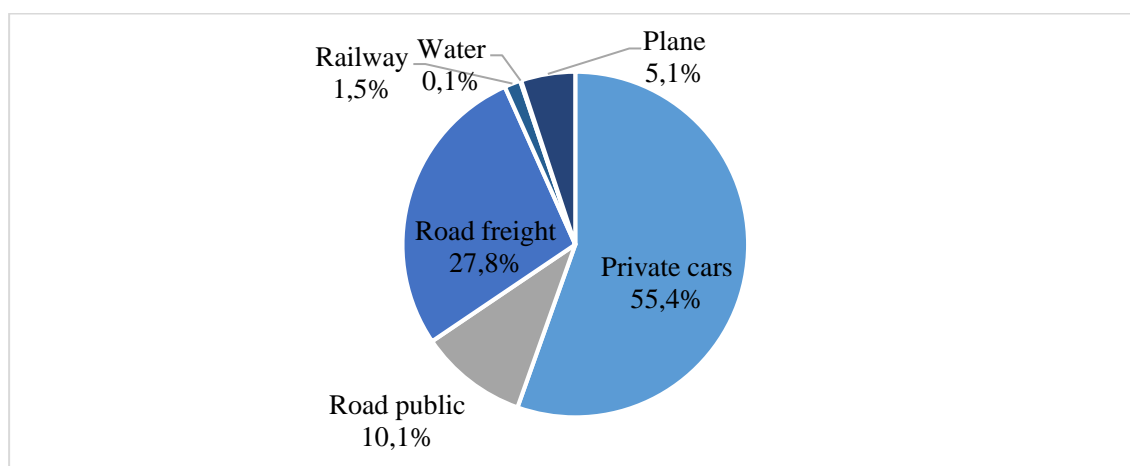


Figure 14.

Emission of CO₂ from transportation in the Czech Republic, 2015

Source: CDV, v.v.i

According to annexes from a conference in Brussels, Czech Republic must increase greenhouse emission to 14% until the 2021 year. Maximum amount expressed 2.6 million tons of CO₂. (“the Czech Republic must decrease emission of greenhouse gasses from transportation or agronomy to 14%”, Adela Denkova, 2016)

By the opinion of Klára Sutlovičová from analytical center Glopolis, the government of Czech Republic chooses the sphere between agronomy and transportation, for decreasing

pollution of greenhouse gasses. (“the Czech Republic must decrease emission of greenhouse gasses from transportation or agronomy to 14%”, Adela Denkova, 2016)

By the words of ecologists from «Rainbow movement», the government of Czech Republic must to encourages the promotion of alternatives to the private car and revive the renewable resources sector, which can provide clean electromobility. (“the Czech Republic must decrease emission of greenhouse gasses from transportation or agronomy to 14%”, Adela Denkova, 2016)

6.3.2. Switzerland

Swiss infrastructure is very good and continues to invest significantly into it. Still build new tunnels and corridors, which accelerates the transport through the Alps to all neighboring states. Swiss railways, renowned for its accuracy and comfort thanks to a discount to various programs easily accessible to the public. (Průmysl, 2016)

The average age of passenger cars is about 8 years, the volume of the engine - an average of 1,975 cubic centimeters. 83% of vehicles equipped with a gasoline engine. In 2015, 4 million cars registered in Switzerland. (LS,2016)

In 2015, decrease number of new cars among all the above transport groups. For example, new cars put into circulation by 7.5% less than in previous years. (LS,2016)

For example, Swiss has introduced CO₂ emission regulation for new cars. These rules entered into effect on 1.07.2012. Switzerland importers must decrease the amount of CO₂ from cars, registered at the first time in Switzerland to average 130 grams per kilometer. If emission of CO₂ per kilometer more than target level issued fines. Rules of the regulation apply to all importers of new cars. (BAC, 2017)

Another example is tax on car depending on engine capacity by formula(D2,2017)

$$\text{CHF}=158+(\text{ car weight* engine capacity})/ 13450$$

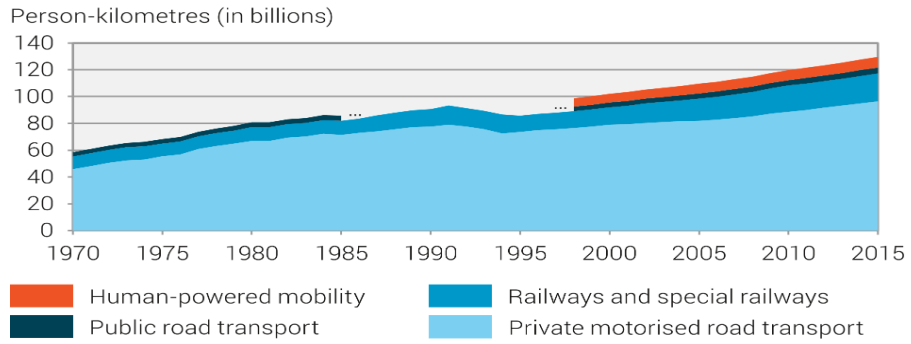


Figure 15.

Passenger transport performance in Switzerland, 2015

Source: FSO

By the way, primary category (2/3) of transport in Switzerland is private transportation. The productivity of private transport more than 5 times than to railways. (FSO,2015)

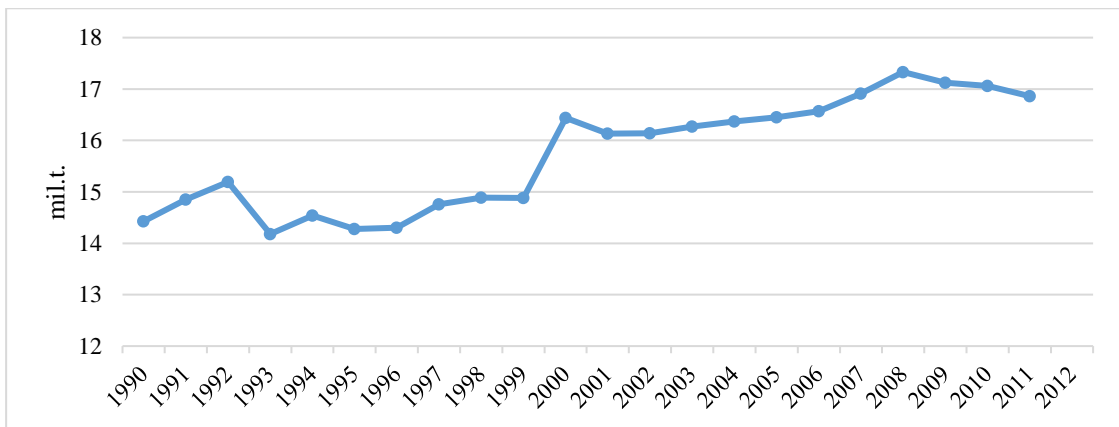


Figure 16.

Emission of CO₂ of transportation in Switzerland, 2012

Source: World Data Atlas

6.4. Emission of CO₂ from energy industry

6.4.1. Czech Republic

Difference from other countries in EU is higher electricity consumption due to higher the share of industry and the relative inefficiency in combination with the export of electricity (17%) and coal-fired plants (> 50%) (Europe 5.6 t per capita/ CZ 2.8 t per capita) (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

One of important reason is electricity mix (difference with Europe 20%), where 60% of energy made by coal power plant. Export of electricity is 17%. (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

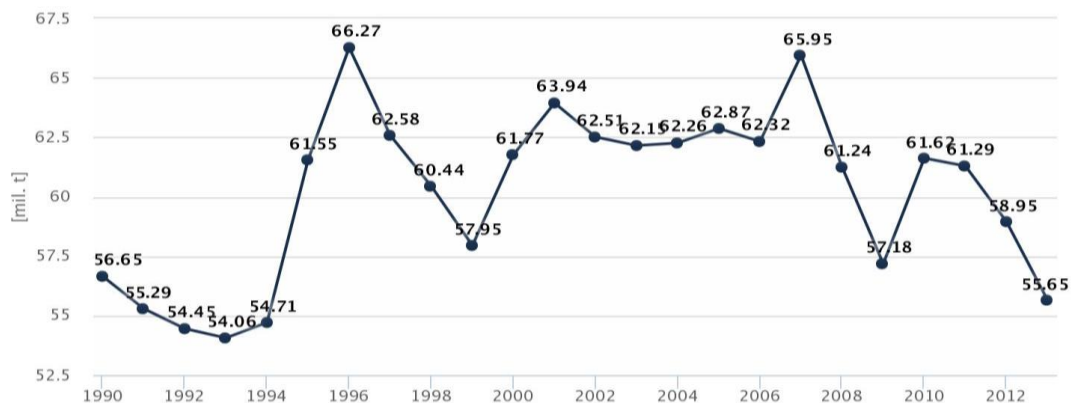


Figure 17.
Emission of CO₂ from energy industry in the Czech Republic, 2013
Source: oEnergetice.cz

The main emission categories are a sector of fuel process, which encompasses except energy industry all of the fuel combustion in transportation, housekeeping, and services. (IPCC, 2013)

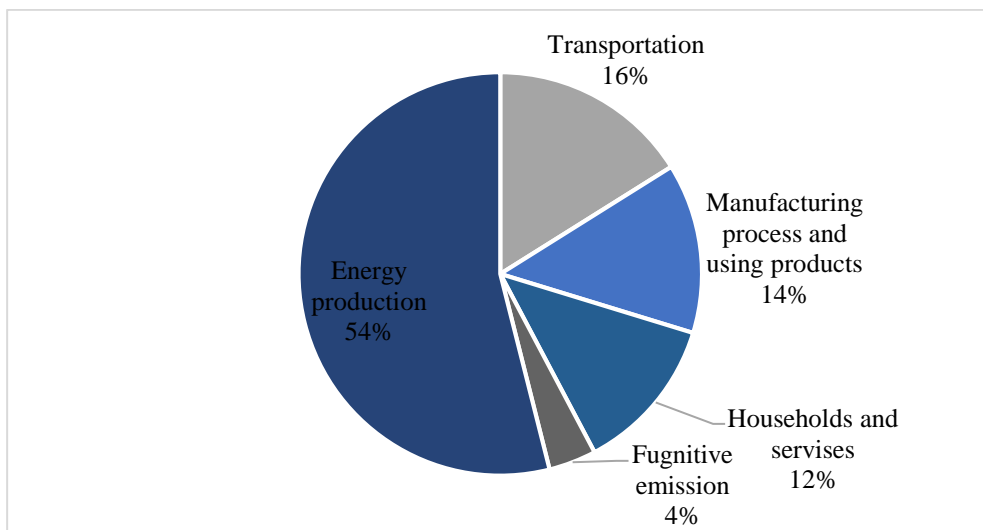


Figure 18.

Structure of emission of Greenhouse gasses to energy industry in the Czech Republic,2015

Source: ČHMÚ

6.4.2. Switzerland

Emissions of CO₂ from electricity consist from 3 IEA categories:

1. Production of electricity and heat energy on heat plants. The aim of producers giving energy to the public.
2. Auto producers, which contains emissions from producing heat and electricity.
3. Other areas of electricity contain emission from fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries. (World Data Atlas,2013)

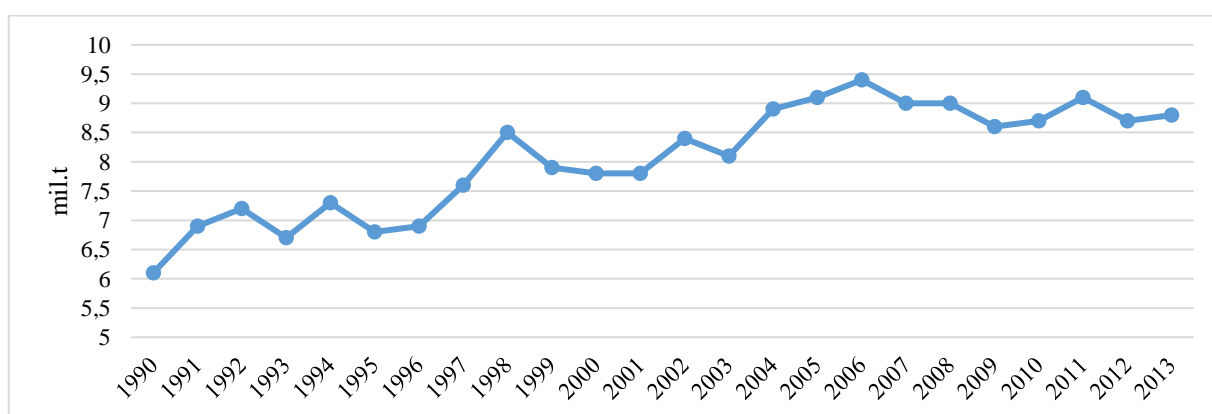


Figure 19.

Emission of CO₂ from energy industry in Switzerland, 2013

Source: World Data Atlas

6.5. Emission of CO₂ from construction and manufacturing industries

6.5.1. Czech Republic

6.5.1.1. Construction

The difference in the construction industry from other countries in EU is lower floor area per capita and high utilization of district heating. (Europe 1, 1 t per capita/ CZ 1, 4 t per capita) (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

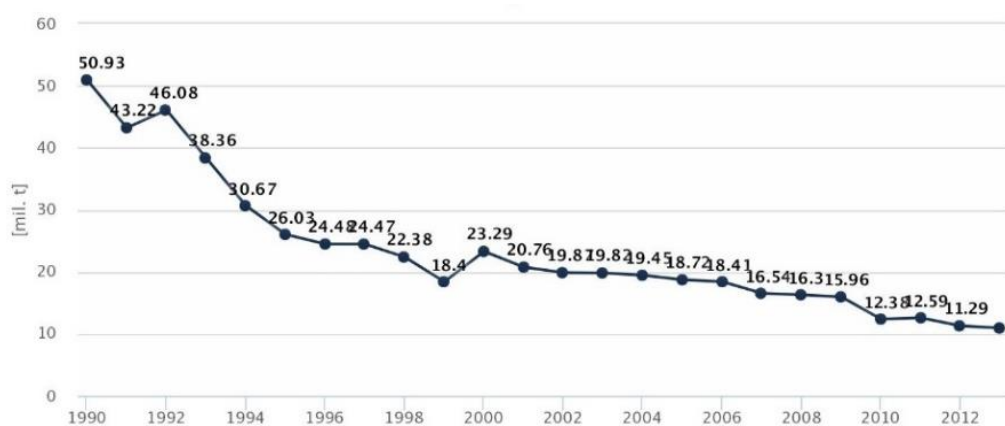


Figure 20.
Emission of CO₂ from construction industries in the Czech Republic, 2013
Source: oEnergetice.cz

6.5.1.2. Manufacturing

Difference in manufacturing from other countries in EU is bigger amount of manufacture to GDP and economic increase of Czech Republic (32% vs 20% Europe) (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

One of the most important reason of air pollution in the Czech Republic is the big influence of manufactures to the economic and big amount of export from this sphere (difference with EU 50-60%). (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

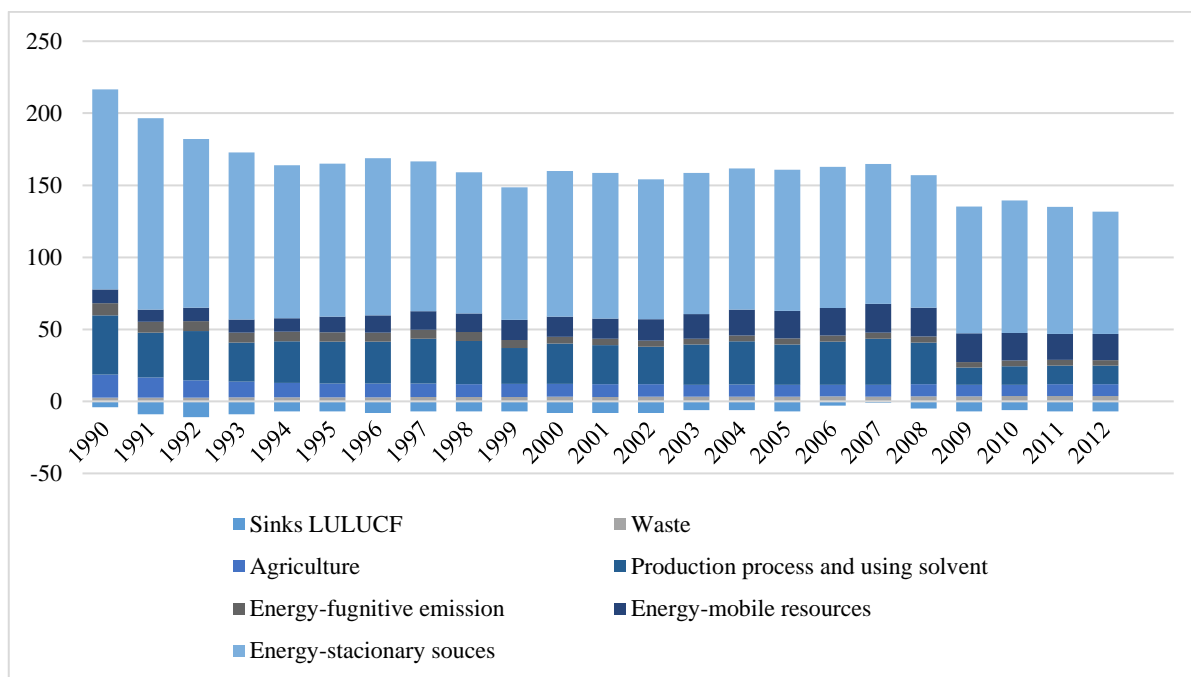


Figure 21.
Emission of CO₂ from mainly areas in the Czech Republic, 2013
Source: ČHMÚ

6.5.2. Switzerland

6.5.2.1. Manufacturing

Switzerland is a country with the powerful economy and a big amount of GDP (670,789 US\$ in 2015). Manufacturing has big influence to amount of CO₂ to atmosphere. (SWI,2016)

For Swiss industry is characterized by high-quality processing of imported raw materials, which are then re-exported appreciation. (Průmysl, 2016)

6.5.2.2. Construction industries

One of explanation of decreasing amount of CO₂ is increasing the quality of building materials because of the efforts of the federal government and the community to reduce the power placed in heating homes. (EIT,2016)

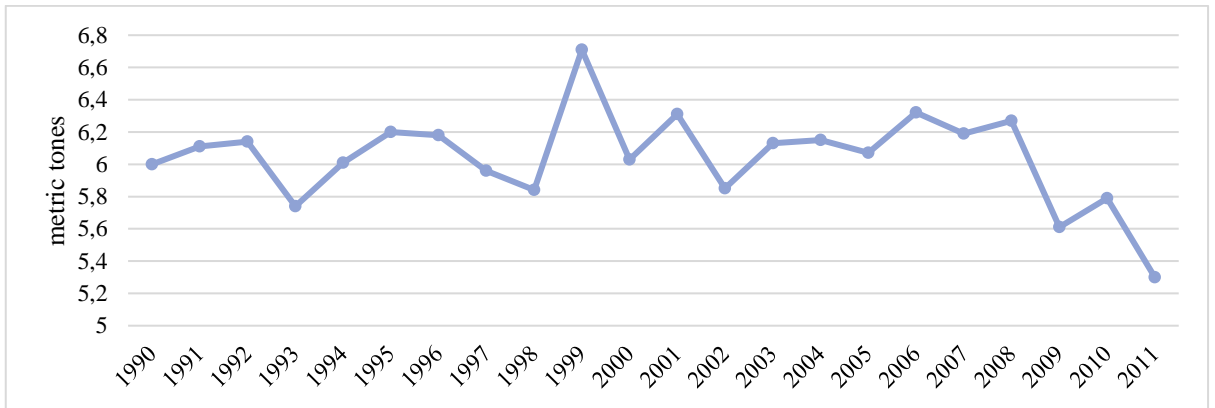


Figure 22.

Emission of CO₂ from manufacturing and construction in Switzerland,2012

Source: World Data Atlas

6.6. Emission of CO₂ from agriculture

6.6.1. Czech Republic

The difference in agriculture from other countries in EU lower using of Reduced use of fertilizers, and less livestock per capita. (Europe 0,8 t per capita/ CZ 1,1 t per capita) (Potential of decreasing greenhouse gasses in Czech Republic, McKinseley, 2017)

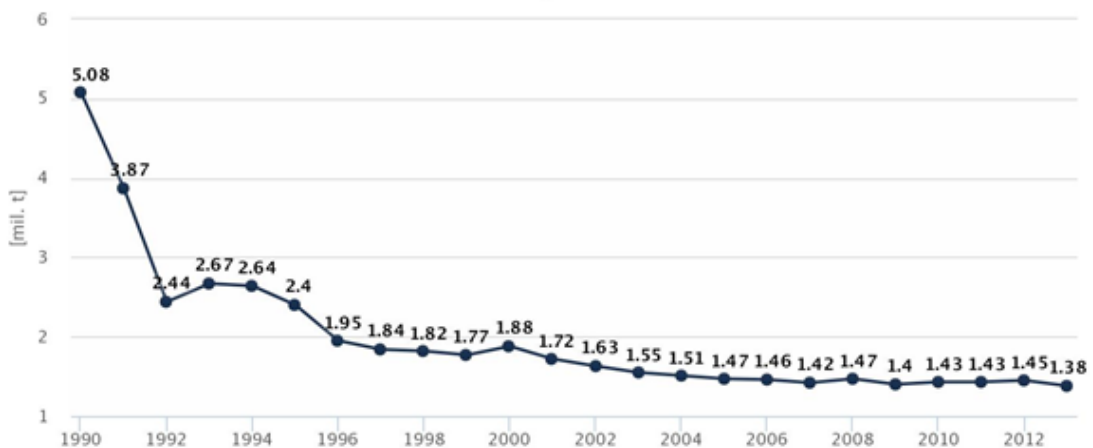


Figure 23.
Emission of CO₂ from agriculture, forestry, and fisheries in the Czech Republic, 2013
Source: oEnergetice.cz

6.6.2. Switzerland

In Switzerland for agriculture using 37% of the total area. 1/3 of the area located in midland. The biggest part of the area is pastures. The most important land-use category of production is cereals. The majority of livestock is cattle farming.

Decreasing of CO₂ emissions with combination to increasing temperature has a negative effect to the quality of land-use categories. This combination decrease amount of protein. (CC,2016)

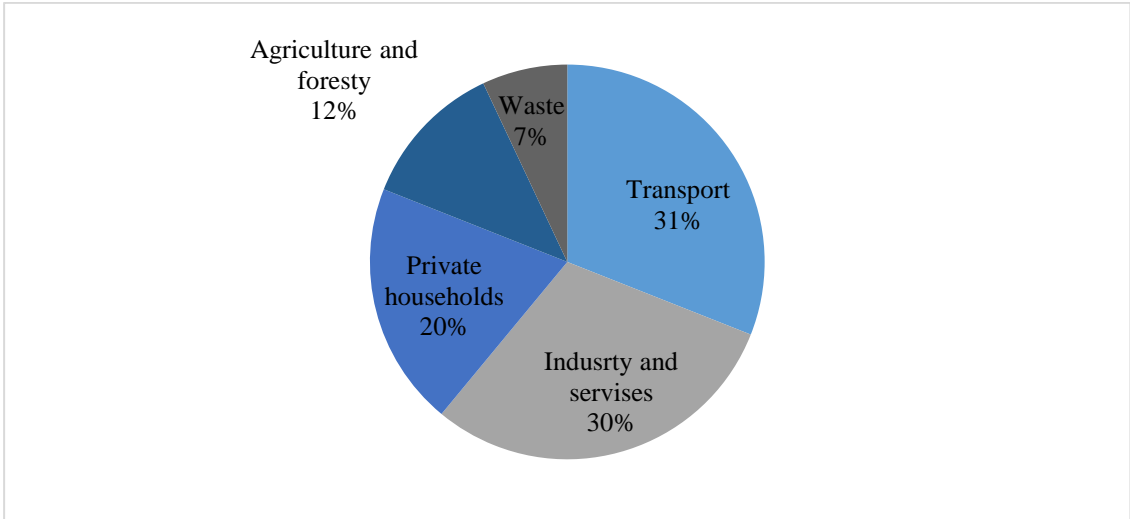


Figure 24.

Emission of CO₂ from mainly areas in Switzerland, 2015

Source: UNFCCC

6.7. Emission of CO₂ in households

6.7.1. Czech Republic

Energy consumption in households constitutes a fairly significant part of total energy consumption. In the Czech Republic, it is the whole quarter, is 25%, which is only slightly less than the consumption of energy in transport. (VZ,2015)

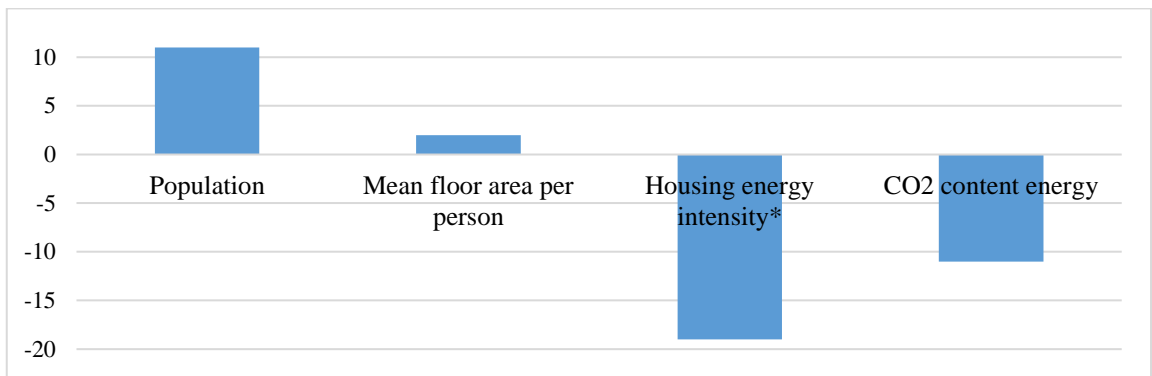
In the Czech household, energy consumption fluctuates. It is due to the fact that on the one hand increases the standard of living of the population, which is related to improved equipment of households with modern appliances. On the other hand, electricity, district heat and fuel more expensive, and therefore people are increasingly choosing efficient appliances, or insulates homes and trying to save energy. (VZ,2015)

With the use of energy in homes is related to the production of hazardous waste, which due to its composition cannot just throw in the garbage. They are mainly used in batteries, electric batteries, lamps, fluorescent lights and electrical appliances. (VZ,2015)

6.7.2. Switzerland

In 2013, Switzerland emitted 47 mln. tons of fossil CO₂. Approximately 40% used in households. Researchers found that household decrease emissions of CO₂ despite increasing population to 13 %. Moreover, this amount of energy using efficiently to 20 %. One of the reason for this result is alternative to fossil fuels like a solar power or minimizing of using fossil energy. (SWI,2015)

As we can see in Figure 24, in the 2015 year expenses from households is 20%.



* Energy intensity is a measure of energy efficiency, expressed as energy consumption per surface unit

Figure 25.

Decomposition of fossil CO₂ emissions from household heating between 2000 and 2013 in Switzerland ,2013

Source: FSO

7. Conclusion

Based on results of the work done, possible to say about differences and commonalities of chosen countries:

- Area of Switzerland 78 866 km²) nearly two-time less than the area of Czech Republic 41 290 km² but the population is approximately same. (The Czech Republic 10 553 843 people and Switzerland 8 401 120 people).
- The total amount of CO₂ in the atmosphere in the Czech Republic is not so harmful. The biggest problem is CO₂ per capita.(≈9,3 metric tons per capita the Czech Republic, ≈4,8 metric tons per capita Switzerland)
- Emission from transportation commensurate in both countries(≈15,73 metric tons per capita the Czech Republic, 16,8 ≈metric tons per capita Switzerland)
- Both of countries use nuclear energy in manufacturing, which in an important part of economics.

Thus, we can conclude that the foregoing determines the need for large-scale and comprehensive measures to prevent, neutralize, or at least significantly reduce the negative effects that generated by motorization in the Czech Republic:

Transportation

- Reduce the environmental hazards of existing engines used oil and synthetic hydrocarbon fuels for motor vehicles;
- Gradual substitution of petroleum fuels to liquefied natural gas (LNG) as the purest of hydrocarbon fuels, with the mandatory creation of the necessary cryogenic infrastructure in the transport sector in the region;
- Decrease average of transport from 15 years to 8 years;
- Not to realize to production cars with planned emission more than 130 grams per kilometer;
- Impose a tax on car depending on engine capacity;
- Improvement of the modern regulatory framework and taxation system of payments for environmental pollution, stimulating the activity and motivation in a population of translation environmentally acceptable technology.

Other areas

- Transition to a completely clean hydrogen fuel would be replaced by ICE engines, equipped with electrochemical generator;

8. References:

1. <http://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution.php> actual for 17.10.2016
2. <http://www.universetoday.com/81977/causes-of-air-pollution/> actual for 18.10.2016
3. <http://environment.nationalgeographic.com/environment/global-warming/pollution-overview/> actual for 31.10.2016
4. <https://www.niehs.nih.gov/health/topics/agents/air-pollution/> actual for 31.10.2016
5. <http://eschooltoday.com/pollution/air-pollution/causes-of-air-pollution.html> actual for 2.11.2016
6. <https://people.hofstra.edu/geotrans/eng/ch8en/conc8en/ch8c1en.html> actual for 6.11.2016
7. <http://www.economist.com/blogs/dailychart/2011/12/energy> actual for 9.11.2016
8. <https://www.epa.gov/ghgemissions/overview-greenhouse-gases> actual for 2.02.2017(methods)
9. Dave Jones, Mara Marthe Kleiner, 2017, Energy transition in the power sector in Europe: State of Affairs in 2016, actual for 2.02.2017
10. http://unfccc.int/kyoto_protocol/items/2830.php actual for 5.02.2017
11. https://ec.europa.eu/clima/news/articles/news_2013100901_en actual for 5.02.2017
12. <http://www.zemepis.net/zeme-cesko> actual for 8.02.2017
13. <https://zpravy.aktualne.cz/domaci/cesko-si-zapsalo-rekord-vyvezlo-nejvic-el-ektriny/r~78ed0922844611e39d22002590604f2e/?redirected=1486546405> actual for 8.02.2017
14. <http://www.autosap.cz/zakladni-prehledy-a-udaje/slozeni-vozoveho-parku-v-cr/> actual for 8.02.2017
15. Adéla Denková, 2016, Emission from cars: EU wants clean air and climate safety. Both effort however, not complement., actual for 9.02.2017
16. Editorial staff *EurActiv.cz*, 2017, Overview: What experienced emission allowances in 2016., actual for 05.01.2017

17. Adela Denkova,2016, “Czech Republic must to decrease emission of greenhouse gasses from transportation or agronomy to 14%”, actual for 11.02.2017
18. http://vitejtenazemi.cz/cenia/index.php?p=emise_sklenikovych_plynu&site=doprava actual for 11.02.2017
19. McKinsey&Company,2017, Costs and potential reductions of greenhouse gas emissions in the Czech Republic, pp.27-33, actual for 11.02.2017
20. IPCC The percentages are calculated from Table 2 Summary inventory of greenhouse gas emissions per the year 2012 (Submission 2014 v1.4) actual for 11.02.2017
21. <http://www.schiedel.cz/cz/neco-malo-o-spalovani> actual for 11.02.2017
22. <http://www.celysvet.cz/svycarsko-statistika-info-stat-zeme-zemepis-cestovani> actual for 23.02.2017
23. <http://www.prumysl.cz/uspechy-ceskeho-prumyslu-v-zahranici-svycarsko/> actual for 23.02.2017
24. <http://www.bfe.admin.ch/themen/00507/05318/?lang=en> actual for 23.02.2017
25. http://www.swissinfo.ch/eng/environmental-target_swiss-to-reduce-greenhouse-gas-emissions-/41295898 actual for 25.02.2017
26. <http://www.indexmundi.com/facts/switzerland/indicator/EN.ATM.GHGT.KT.CE> actual for 25.02.2017
27. <https://knoema.com/atlas/topics/Environment/Emissions/CO2-emissions-electricity-production-percent?baseRegion=CH> actual for 25.02.2017
28. http://www.swissinfo.ch/rus/article/41809392?ns_mchannel=rss&link-Type=guid&srg_evsource=unet 25.02.2017
29. <http://www.skf.com/ru/our-company/the-power-of-knowledge-engineering/the-power-of-knowledge-engineering/lower-truck-emissions/index.html> actual for 25.02.2017
30. <http://www.tehnoinfo.ru/polimer/116.html> actual for 25.02.2017
31. Celia Luterbacher,2016, The Swiss houses making energy go a long way, actual for 26.02.2017
32. <http://www.energyintime.eu/switzerland-reduces-its-co2-emissions/> actual for 26.02.2017
33. <http://www.climatechangepost.com/switzerland/agriculture-and-horticulture/> 26.02.2017

34. <http://www.ecolosorse.ru/ecologs-299-1.html> actual for 4.03.2017
35. Korobkin V.I. Ecology.-M., 2016.-456 p actual for 4.03.2017
36. <https://www.drive2.ru/l/288230376152762726/> actual for 4.03.2017
37. <http://ladoshki.ch/news/view/bolee-chetyrh-millionov-avtomobiley-kolesyat-podorogam-shveycarii#> actual for 4.03.2017
38. <http://www.radio.cz/ru/rubrika/novosti/srednij-vozrast-avtomobiley-v-chexii-151-goda> actual for 4.03.2017
39. http://www.vitejtenazemi.cz/cenia/index.php?p=spotreba_energie_v_domacnos-tech&site=energie actual for 4.03.2017
40. <http://www.geology.cz/svet-geologie/poznej-geologii/geologicka-temata/ukladani-co2> actual for 4.03.2017
41. http://tspu.ru/res/geogr/ecology/t_06.htm actual for 4.03.2017