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УНИВЕРЗИТЕТ НА ЈУГОИСТОЧНА ЕВРОПА
SOUTH EAST EUROPEAN UNIVERSITY

FAKULTETI I SHKENCAVE DHE TEKNOLOGJIVE BASHKËKOHORE
ФАКУЛТЕТ ЗА СОВРЕМЕНИ НАУКИ И ТЕХНОЛОГИИ
FACULTY OF CONTEMPORARY SCIENCES AND TECHNOLOGIES

POSTGRADUATE STUDIES – SECOND CYCLE

THESIS:

Analyses of Ecological and Energy Footprints as Indicators of Energy Management in the Transition to Sustainability using Social Networks

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Tetovo, May 2019

И З Ј А В А

Под целосна морална и материјална одговорност изјавувам дека текстот во мојот труд, на тема „Анализи на еколошкиот и енергетскиот отпечаток како индикатори за Енергетски Менаџмент при транзиција кон одржливост со користење на социјални мрежи“ е мој автентичен и самостоен труд и е резултат на моите сознанија направени во текот на истражувањето, како и на теоретските сознанија и практичните искуства од соодветната област и истиот, освен во деловите што се означени со референци, претставува исклучиво мој труд. За секое неовластено користење на туѓ текст или труд или плагијаторство, согласен сум да ги сносам соодветните дисциплински, граѓански и кривични последици.

Тетово, 31.04.2019

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D E C L A R A T I O N

Under complete moral and material responsibility, I hereby declare that the text in my thesis “Analyses of Ecological and Energy Footprints as Indicators of Energy Management in the Transition to Sustainability using Social Networks” fully represents my own authentic work, and is the result of the research that was carried out, as well as the theoretical basis and practical experiences in the said area, except for the sections that have been referenced. I am prepared to accept appropriate discpilinary, civil and criminal charges for any unauthorized use of text or plagiarism.

Tetovo, 31.04.2019

Signature of declarant:

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Bojan Mihajlovski

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Abstract

The global community is using natural resources very intensely – at rates exceeding nature's ability to regenerate their productivity potential. Nature can renew its resources, however, only at a certain pace. People are constantly consuming more renewable resources than nature is able to regenerate.

Sustainable development means that the needs of the present generation should be met without compromising the ability of the future generations to meet their own needs.

The entire shift of the progress of civilization to "sustainable development" depends to a large extent on the transition from the use of conventional energy sources to alternative ones, and in order to promote alternative sources, it is necessary to emphasize that the basic tool for this endeavor is Energy Management. The main goal of Energy Management is to increase profits by reducing costs in all forms of energy consumption, while one of the most important specific goals is the reduction of the emissions of harmful gases, as well as the reduction of air pollution.

In an emerging sustainability science, much work has been done on indicators of sustainable development. The Ecological and Energy Footprints, as indicators of sustainability, reflect humanity's anthropogenic impact on global ecosystems. Biocapacity is the ecosystems' capacity to produce biological materials used by people, as well as to absorb waste material generated by people, and CO_2. Basically, it is the comparison between the needs of humanity and the planet's capacity to regenerate, representing the surface of biologically productive land and sea, which is necessary to supply the renewable resources a human population consumes, and absorb CO_2 and the waste produced in that process.

The Personal Ecological Footprint provides insight into how everyday individual activities and habits have a harmful environmental impact and impede sustainable development. It shows what kind of personal or collective action we can undertake to mitigate our harmful influence. There are many approaches that governments and industry can take to reduce environmental degradation. However, one of the most difficult issues to address is how to change the day-to-day behavior of individuals. It is an undeniable fact that a very stressful and fast "pace of living" prevails in most parts of the planet. However, a very small percentage of people would replace this with a lifestyle from the distant or near past. We believe that the desired goal will be achieved by raising awareness of sustainable development, and education, and then by adjusting the "unsustainable habits" and changing people's attitudes toward nature and its resources.

Preface

Sustainability is a concept that we come across everywhere. Companies are characterized as sustainable, and are making efforts to incorporate sustainability objectives, actions, and standards in their working agendas and logistic networks. National and regional administrations set sustainability objectives, set norms and standards of efficiency, give support to increased use of public transport, and encourage people to reduce, reuse, and recycle. Colleges compete for sustainability recognitions, making various attempts, from upgrading energy and water efficiency use to creating syllabus proposals. Analysts concentrate their observations on disseminating new information and practical applications to encourage sustainability. Customers take into consideration issues about sustainability while purchasing chemical-free, or guaranteed sustainable seafood or forest commodities. People do their best to diminish their Ecological Footprints on Earth out of an obligation toward their descendants.

Sustainable development is also an extensively exploited term. It is frequently used in summit conferences of the United Nations, the World Bank, and NGOs, and is the most important goal of the European Union and numerous developed and non-developed countries. The World Business Council for Sustainable Development calculates numerous outstanding international companies among its representatives. They are trying to assist nations, corporations, and societies "in evolving" not only in the immediate future, but for their well-being in many years to come.

Research Field, Research Aims, Research Hypothesis

Research Field

The research field falls in the multidisciplinary intersection of environmental dimension, energy management and social networking. Sustainability and sustainable development are terms widely used and present a challenge to ensure a continuous improvement in the sphere of ecology, quality of life, and well-being for present and future generations.

Unsustainable trends, such as climate change, energy usage, poverty and social exclusion, demographic pressure and aging, threats to public health, use of natural resources, and loss of bio-diversity, are all processes which call for a high level of urgency. The destiny of future generations is in the hands of the present generation, which has an obligation to preserve the planet's capacity to support life with its complete diversity, as well as to ensure sustainable development.

Sustainable development includes three mutually-dependent and interrelated dimensions:

- An environmental dimension (natural resources, protection, sustainable use of nature, and a fight against pollution);
- A social networking dimension (social resources, social aspects);
- An economic dimension (economic resources, development and growth).

The entire shift of the progress of civilization to “sustainable development” depends to a large extent on the transition from the use of conventional energy sources to alternative ones, and, in order to promote alternative sources, it is necessary to emphasize that the basic tool for this endeavor is Energy Management (EM). The main goal of EM is to increase profits by reducing costs in all forms of energy consumption, while one of the most important specific goals is the reduction of emissions of harmful gases, as well as the reduction of air pollution.

The sustainable indicators reflect the trends in socio-economic development, sustainable consumption and production, social inclusion, demographic changes, public health, climate change and energy, natural resources, sustainable transport, and trends in global partnership and good governance. The sustainable indicators are defined in accordance with the European Strategy for Sustainable Development, and are calculated according to a methodology harmonized with that of the European Union. Therefore, they are comparable with the sustainable development indicators in European countries, and they are a good platform for monitoring the priorities in national policies for sustainable development.

Ecological and Energy Footprints as indicators of sustainability, and Ecological and Energy Footprint calculation provide a baseline from which progress is measured toward a more sustainable lifestyle, and a smaller Footprint.

An Energy Footprint is a measure of land required to absorb CO_2 emissions. This approach focuses on the outcome of energy use that is CO_2 emissions.

Research Aims

The aim of this research study is to investigate the current situation in energy management issues (increased energy use, limited raw fuel reserves, global warming, etc.), and then develop and increase awareness and perception of the Ecological and Energy Footprints as indicators of sustainability and energy management. The model to be developed for this purpose is called the Ecological and Energy Footprints Analysis Model (EEFAM), which offers metrics for comparing the Ecological and Energy Footprints with the available biocapacity. A case study has been carried out.

Social networks will be used to analyze and measure the values of the personal Ecological and Energy (CO_2) Footprints as indicators of sustainability. By using social networks, important information can be obtained about the attitude of the individual toward nature, and the awareness of their impact on the habitat. This analysis will enable us to undertake personal and collective initiatives directed toward a more rational use of the existing resources, as well as to increase the quality of life and sustainability. A survey and questionnaires will be used as quantitative methods of data collection, and will be distributed through social networks such as Facebook and Twitter to analyze and measure the respondent inputs. Also, focus groups for capturing the qualitative input will be used within the social networks.

For some time now, the general public has undertaken an initiative for an inclusive set of sustainable development and energy management objectives, and a number of measures have been undertaken worldwide. They are aimed toward reducing starvation and impoverishment; improving medical protection, birth prevention and schooling; providing conditions for the creation of a low-emission society; and, improving agricultural productivity, while decreasing habitat deterioration. Today, thousands of administrative and non-administrative corporations, private companies and persons around the globe have accepted the concept of sustainability and energy management, and have started to raise awareness, and funds, for sustainability and energy management plans. Companies have provided metrics to follow the economic, social and environmental effects of their activities. The overall aim of sustainable development is to develop a set of actions and measures that will enable continuous improvement of the quality of life, both for the current and future generations, through the creation of sustainable communities, which will be able to manage and use resources efficiently, and apply the ecological and social innovation potential of the economy, ensuring prosperity, environmental protection, and social cohesion. For this reason, one of the directions of future development should aim at strengthening the whole system for implementing sustainable development and energy management, including a holistic approach, instead of the present, fragmented one. The aim of the Ecological and Energy Footprints, as indicators of sustainability, is to prove that the present way and rhythm of living is not sustainable. Therefore, it is important to take concrete actions to inform society about the importance of the Ecological and Energy Footprints. Additionally, the Ecological Footprint can serve as a useful means of education, teaching people about the Earth's limited capacity, and human overconsumption, with the aim of changing individual lifestyle, arguing that many contemporary lifestyles are not sustainable.

Research Hypothesis

The starting hypothesis of this study is that raising the awareness and perception of the Ecological and Energy Footprints increases the impact they have on sustainability.

By analyzing and measuring the values of the personal Ecological and Energy Footprints, as indicators of sustainability, and by using social networks, important information can be obtained about the attitude of the individual toward nature, as well as the awareness of their impact on the habitat. This analysis will enable us to undertake personal and joint initiatives directed toward a more rational use of the existing resources, as well as increasing the quality of life and sustainability.

According to statistical data and fact-oriented material which has been collected, it is anticipated that the research will reveal a low awareness among respondents about the impact they have on sustainability with their personal lifestyle.

Thesis Structure

This thesis consists of seven chapters and four annexes. The titles of the chapters are as follows:

- Chapter 1 – Introduction;
- Chapter 2 – Literature Review;
- Chapter 3 – Research Methodology;
- Chapter 4 – Case Study Analyses;
- Chapter 5 – Ecological and Energy Footprint Analysis Model;
- Chapter 6 - Results from Measurements, Metrics and Statistics; and
- Chapter 7 – Conclusion.

Chapter 1 – Introduction

The first part of Chapter One deals with the motivation, importance, and who the topic of this thesis is intended for. The second part of this chapter is dedicated to the concepts of *sustainability* and *energy management* as a common framework, not only for developing sustainable energy systems, but also for decreasing the Ecological and Energy Footprints.

The motivation for this thesis is to explain and quantify the impacts of humanity on Earth's eco-systems if we wish to manage the planet sustainably for the benefit of both human well-being and our natural heritage.

The importance of the thesis is to highlight, through theoretical considerations and research, the Ecological and Energy Footprints within the framework of sustainability and energy management concepts. At the same time, it is also essential to point out to one of the ways by which sustainability and energy management are achieved, which is a balance between human needs (primarily energy) and the biocapacity of the Earth, and can be accomplished by an Ecological and Energy Footprint Analysis.

The topic of the Ecological and Energy Footprints, as well as the Carbon Footprint, is rapidly gaining importance. Nowadays it has become a hot topic worldwide. The aim of the Ecological, Energy, and the (unavoidable) Carbon Footprint is to prove that the present way and rhythm of living is not sustainable. Therefore, it is important to take concrete action to inform society about the importance of the Ecological and Energy Footprints, and, with that, to raise public awareness. (Ruževičius, 2010)(p. 23).

The information which is revealed in the research is intended to help the Faculty administrations in their future directions for a more sustainable university. Moreover, students need to think on a personal level about how they can reduce their impact on nature. As the study shows, a reduction in carbon intensive activities and energy consumption, as well as a decrease in the dependence on forest- and cropland-based products may be a practical way to reduce one’s personal ecological and energy impact. In light of our present dilemma with the emergence of climate change in which greenhouse gases are the main cause, our prediction is that students at the university will show to have a greater impact in terms of carbon emissions as compared to other types of environmental impacts. This, essentially, will call for a thorough and massive information dissemination with regard to Energy Footprint reduction, energy efficiency, as well as the promotion of sustainable lifestyles around the campus, such as: walking or biking rather than driving, consuming organic foods, energy conservation, and so on. In this context, the Ecological and Energy Footprints can be used as an educational tool, apart from being a policy tool, especially for climate change mitigation, as well as for addressing natural resource degradation. Thus, we shall provide reasons for the importance of noticing and recognizing the multiple co-operation in the socio-environmental structure in which striving toward sustainability and better energy management takes place.

Sustainability is a term we hear all around us. Corporations label themselves as sustainable and try to build sustainability goals, measures, and metrics into their business plans and supply chains. State and local governments set sustainability targets and pursue them, installing efficiency standards and practices, encouraging the use of public transportation systems, and motivating citizens to reduce, reuse, and recycle. Universities compete for sustainability awards that recognize efforts ranging from improving energy and water-use efficiency to curricular offerings. Researchers focus their attention on the development of new knowledge and technologies to promote sustainability. Consumers consider sustainability concerns as they buy organic, or buy certified sustainable seafood or wood products. Individuals try hard to reduce their Ecological and Energy Footprints on the planet out of a sense of responsibility toward the younger generations. (Matson, et al., 2016)(p. 1)

1.1 History is repeating itself

The development of the concept of sustainability goes back to ancient times. For hundreds of years people have understood the need for a bigger life-support system than the Earth can provide. This understanding is apparent in people planting seeds in the ground, protecting native flora and fauna, and preserving rivers, lakes and seas.

The state of planet Earth

The expansion of the industrial revolution in the early 1970s, as well as the exponential increase of the global population are the main causes of a sudden and permanent increase in consumption of limited natural resources. Analysis of data from the time of the industrial revolution and data from the present indicates that consumption of the Earth's natural resources has doubled. Humanity is now in an ecological deficit, or as scientists call it, "ecological overshoot". More precisely, current consumption and annual needs for natural resources are far greater than what the Earth can regenerate for a period of one year. Also, the amount of carbon dioxide emitted and the waste generated every year exceeds to a great extent the amount that the planet is able to absorb during the same calendar year.

Thus, the social, economic and environmental development of mankind, which at the same time draws natural resources and creates waste, is not even close to a sustainable one. The most commonly quoted statement of the "Our Common Future" report from the World Commission on Environment and Development (WCED) - "Brundtland Commission" held in 1987, is precisely the definition of the term *sustainable development*: "a development that meets the needs of the present, and at the same time does not jeopardize the ability of future generations to meet their needs" (UN 1987). In this report, for the first time, sustainable development is defined not only as an economic category, but also as a humane, and, above all, an environmentally sustainable category. The phenomenon of the greenhouse effect, global warming, the loss of diversity, the exhaustion of non-renewable energy resources, the water deficit, and the fact that every year about 10 million people die of hunger (of which 6 million children), has led humanity to think about sustainable development not only as a theoretical concept, but rather as a principle that must be applied urgently in practice. Looking back in history, we notice that people have always given priority to economic factors rather than environmental ones. It is an undeniable fact that the global economy depends on how stable the biosphere is capable of providing a permanent resource reserve necessary to meet the basic human needs for living today, such as food, water, fibers, energy, etc. Ecological overshoot due to its global scale and the tendency of further growth has a negative impact on the economies of even the countries with the best economy in the world. (Lukić, 2011)

Nevertheless, the idea of sustainability in actual appearance was mostly highlighted by the United Commission on the Environment (UNCED) in 1987. At the time, Gro Brundtland, chairperson of the Commission, wrote the following text: "*Environment is where we live; and development is what we all do in attempting to improve our life within that home. The two are inseparable*." The Commission claimed that sustainability "*meets the needs of the present without compromising the ability of future generations to meet their own needs*." (Commission, 1987) Brundtland's persuasively written description convinced the audience that the change to sustainability would help to slow down and bring an end to the deterioration of the eco-life and of Earth's reserves globally. Since the request for Global Action by the Brundtland Commission, the UN has emphasized the importance for change to sustainability by organizing a number of symposiums and signing contracts which have triggered numerous Conventions and Declarations of global importance and they can be reviewed in Annex for Chapter 1.

The social perception of sustainable development is quickly developing as a consequence of these symposiums. It is expanding from satisfying Brundtland's human needs toward inclusive social well-being. Well-being is the state of being comfortable, healthy, and secure due to having basic needs met, as well as having access to health, education, community, and opportunity. The essence of the human experience of well-being is a combination of material, social, and personal fulfillment. Inclusive social well-being is well-being of individual people gathered across space and time. Matson et al. define development to be sustainable over places and times in which inclusive social well-being does not decline. They often use the expression "inclusive well-being" or just "well-being". (Matson, et al., 2016)(p. 21)

How can we, as individuals, contribute toward achieving social well-being? In this thesis we shall try to answer this question by using a structural diagram of sustainable development.

1.2 Structural diagram of sustainable development

The structural diagram for the analysis of sustainable development will be presented here. If all-inclusive social well-being does not decrease in a couple of generations, the development is considered to be sustainable. Well-being is achieved through the consumption of goods and services that are based on five basic capitals (reserves): natural, manufactured, human, social, and knowledge capital. If the complete potential of these capitals deteriorates over time, social well-being will decrease, and the development will be considered unsustainable. The strategy of stimulating sustainability is primarily the way to handle these capitals, and people's access to them. These capitals are presented using the structural diagram shown in Figure 1.

At the top of Figure 1 are the objectives of sustainability and sustainable development. The structural diagram extends the Brundtland Commission's sustainability goal of "meeting people's basic needs", with a more extensive objective on their well-being. For a number of people, the vital components include the ability to satisfy their existential needs for food, water, shelter, energy, and physical security. A number of people will expand this list with elements that make life good, such as: health, education, community, and opportunity. But, sustainable development has always been about all humanity. Therefore, our attention focuses on complete inclusive social well-being: *social* because it is intended to be more than just the individual's well-being, and *inclusive* because of the justice between and among generations. Though our objective for sustainable development is categorized in relation to inclusive social well-being, we will condense it to well-being for the remainder of this thesis.

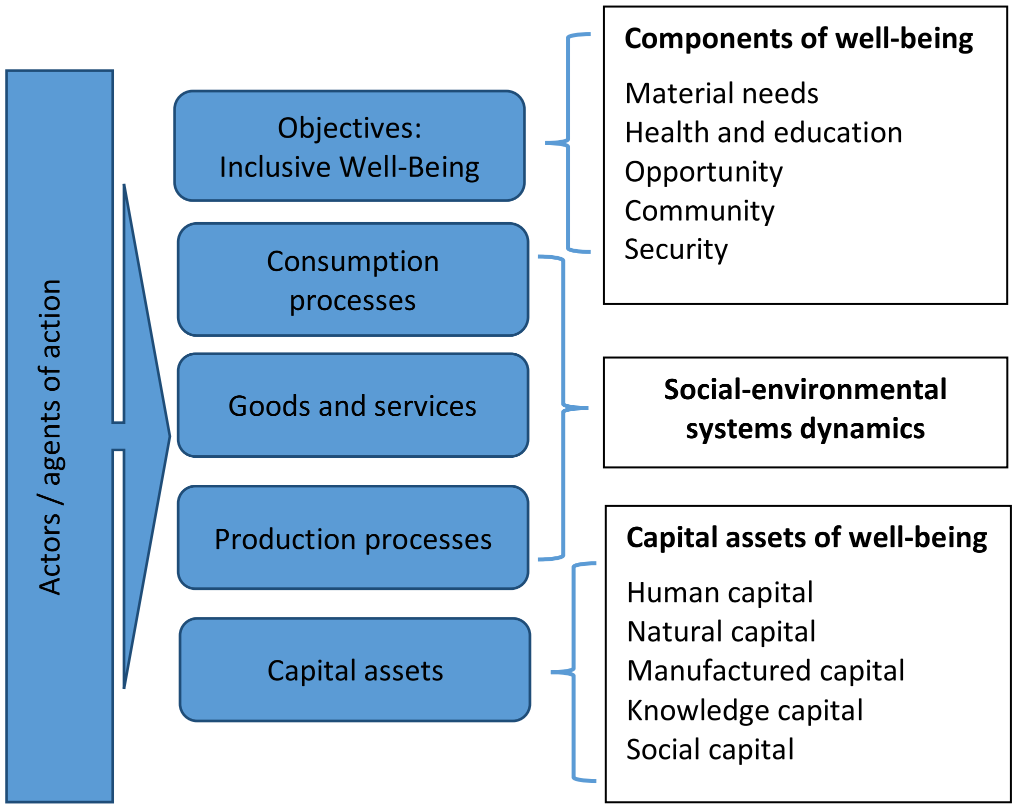

Figure 1 - A structural diagram for understanding and pursuing sustainability (Matson, et al., 2016)(p. 16)

At the lowest part of Figure 1 lies the foundation of capital assets, which are the most significant elements for well-being. All of these capitals are the "fuel in the tank" that strengthens development and on which society relies to create its well-being. The structural diagram explained here provides characteristics about society's assets in terms of the five element "capitals": natural, manufactured, human, social, and knowledge capital. A brief description of each of these terms is presented in Table 1, as well as their general relevance in connection with our topic.

Capital Asset	Key Elements or Characteristics	Associated Fields of Study
Natural capital	Land, water, biotic, mineral resources; climate and atmosphere; biodiversity; etc.	Geography, Earth systems science, ecology, conservation biology, natural resources, ecological economics
Human capital	Human population (size, distribution, health, education, other capabilities)	Demography, health and medicine, education, labor, geography
Manufactured capital	Buildings (homes, factories and their products); infrastructure (transport, energy, information)	Industrial ecology, green design, pollution control, sustainability engineering, geography
Social capital	Laws, norms, rules, customs; institutions (political, judicial, economic); trust	Political economy, institutions, policy, government, sociology, law, geography
Knowledge capital	Codified knowledge (conceptual, factual, practical, know-how)	Studies of policy, innovation and design, science & technology, social, geography

Table 1 - Key elements of capital assets and some scholarly fields that study them (Matson, et al., 2016)(p. 17)

Another characteristic of the structural diagram for sustainability research is presented on the left-side pane in Figure 1, which helps us remember the significance of actors[1] and agencies[2].

The structural diagram has been perceived as functional because it makes us think of the numerous aspects of sustainability problems. Our first step on that journey is to take a closer look at the meaning of well-being.

1.3 Constituents of well-being

How does a person understand well-being? Well-being is undoubtedly complex, but in numerous evaluations there are repeated elements. The focus is on the five components of well-being that frequently come up in everyday conversation, and become evident as an outcome of investigation. These components are: material demands, health, education, opportunity, community and security. In the next part we will focus only on the material demands because they are the most closely connected with our topic.

1.3.1 Material demands

Individuals have different ideas of demands (depending on whether they are poor or rich), but, at the most fundamental level, people demand food, water, energy, and housing for staying alive. When these material demands are met, they supply the basis of well-being from which they pursue individual or career development.

Satisfying the material demands and lack of food needs the engagement of basic capitals. Natural capital (such as water resources, crops and agricultural land, fossil fuels, minerals, air and climate) is the capital which provides products and services that people demand or lack. Activities in manufacturing capital can have an almost devastating impact on natural capital, depending on how they are implemented. Sustainable development will have to focus on supplying assistance to material demands without putting a heavy and/or unsustainable load on natural capital. Upgraded knowledge capital (for instance, in the form of upgraded varieties of crops and improved knowledge of nutrition) and social capital (for instance, in the form of international agreements, property rights, economic policies and cultural practices) will definitely be needed in order to meet material demands and to make improvement more sustainable.

[1] Actors are the people, groups or organizations that are involved in the decision-making process, or that will be affected by the decisions. Actors can be as large as countries or multinational organizations, and as small as households or individual people.

[2] Agency is the degree to which a given actor has the capacity to act independently and to make their own decisions.

1.4 Capitals (capital assets) of well-being

In the structural diagram of sustainable development (see page 5), inclusive social well-being is helped by a wide variety of goods and services which are drawn from, generated, and conditioned by the capital assets of the Earth, which are human capital, natural capital, manufactured capital, knowledge capital and social capital. In the next part we explain only the manufactured capital, which is most closely connected with our topic.

1.4.1 Manufactured capital

This capital involves: manufacturing facilities and the products they manufacture, transport, housing, technical knowledge about farms, water-cleaning, etc. Manufactured capital can be of help to individual well-being by supplying food, housing, energy, security and enjoyment; and it is necessary for an effective approach to natural capital. The total of manufactured capital generated around the globe quickly piles up. In spite of providing numerous advantages for personal well-being, manufactured capital, at the same time, may harm other capitals (capital assets), and in this way possibly reduce the aspiration for achieving sustainability. For instance, the destruction of forestry for supplying manufactured resources may cause a total diminishment of natural capital. In the same way, releasing green gases by energy production for manufactured capital may affect a person's health and harm human and natural capital, as well as their well-being. However, the most significant point is that these unfavorable conditions can be avoided. Managed forests could be kept sustainable so that the reduction of natural capital will become a very slow process. The release of green gases can be driven to the lowest point possible, and resources can be used over and over again, diminishing the negative effect on natural and health capital.

The goods and services obtained by manufactured capital are frequently transferred from poor to richer parts of the world, while what remains in the poor countries are only the unfavorable consequences (pollution, bad working conditions, and low salaries). This injustice gives rise to consumer patterns of behavior (the wealthiest 20% of the global population are related to 76% of overall private consumption) (Biermann, 2014), as well as to applying more rigorous ecological rules in wealthier parts.

Researchers, designers and inventors are now occupied with stimulating recently developed activities that can improve the objectives of sustainability. Green design (sustainable design), de-carbonization (removing carbon from manufacturing processes), the development of biotechnology, and the "cradle-to-cradle" model (Braungart & McDonough, 2010) for diminishing garbage represent new ways that are being promoted.

1.4.2 The combination of capital assets

The five capitals can combine in a manner that upgrade human beings. Individuals are gaining an understanding as regards how to increase consumption only in what they really require, and diminish consumption of what they do not. For example, the harmful consequences of the production and consumption of energy can be diminished by the engagement of recently-developed proposals and innovative technical knowledge.

The next part will be devoted to energy management strategies in households, companies, and administrations stimulating and adjusting the formation of a kind of manufactured capital, which keeps the habitat in good condition, the citizens in better physical and mental condition, increases their knowledge, and makes them more capable of designing and applying new methods for improving life on Earth.

1.4.2.1 Energy management and sustainable development

One of the major issues facing civilization today is the provision of sustainable energy supplies for an expanding and increasingly productive world. The well-known global problems refer to: increased energy use, limited raw fuel reserves, increased living standard pressure, and global warming.

The entire shift of the civilization progress toward “sustainable development” depends to a large extent on the transition from the use of conventional energy sources to alternative ones. In view of the above, and in order to promote alternative sources, it is necessary to emphasize that the basic tool for this shift is energy management.

The concept of *energy management* includes energy efficiency, energy saving, energy tariff, and determining the appropriate type of energy and its price. A close link between energy and the environment has highlighted the issue of energy management. The fundamental goal of energy management is to produce goods and provide services with the least cost and the least environmental effect. (Ruteh, 2011) (p. 164)

1.4.2.2 Better Together: Energy Management and Sustainability Programs

Both energy management and sustainability programs lead to controlling efficiency, as they are both based on a foundation of continuous improvement. They are mutually beneficial; sustainability measures can be a positive influence on energy management to encourage looking beyond immediate cost reductions and invest in initiatives such as renewable technologies. The energy management measures can provide practical solutions to the sustainability assignments to reduce energy that contributes to an overall reduction of carbon emissions. (Jamieson, 2014)

Working together, these measures and assignments can address all aspects of energy demand, energy supply and sustainability to ensure a facility reaches its potential efficiency, maximizes cost savings, decreases its Environmental Footprint, and builds transparency. Working together will address the issue of developing sustainable energy systems in a period of profound and rapid change of national and regional energy markets (SEEU, 2019).

1.5 Energy management and sustainability

1.5.1 Mission, scope, and history

Energy management and sustainability programs differ in terms of mission, scope, and how established they are. Understanding these differences can help communication.

	Energy Management	Sustainability
Mission	Reduce costs, increase operational efficiency, energy audit	Environmental savings, social benefits, increase transparency
Scope	Energy management policy, strategy and execution	Environment, social and economic
Organizational history	Established	Relatively new

Table 2 - Energy management vs. Sustainability: Mission, Scope, Organizational history (Jamieson, 2014)

Any of the mentioned methods of energy management would in a way lead to an increase in energy efficiency. Over a long term period, this increased energy efficiency would have many effects on the economy by reducing costs and making stable energy for developing.

1.5.2 Long-term ways of achieving sustainable energy by energy management

There are two main ways of achieving sustainable energy: first, macroeconomic planning in the field of energy, and second, operational measures on a micro level.

1.5.2.1 From a macroeconomic point of view

From a macroeconomic view point, the most prominent clean and low-carbon energies and related infrastructures are the following:

Electricity generation from natural gas: it seems that a share of natural gas in electricity production will be highlighted by 2050 and reach 28% from the current 23%, so that generated electricity in that year would be more than twice the same production level in 2033. (OECD/IEA, 2006) CO_2 production from natural gas is roughly half of coal per kilowatt hour electricity. Considering the advances made in power generation technologies, the efficiency of combined cycle power plants has reached 60%, and using these technologies would significantly reduce pollution levels. (Ruteh, 2011)

Energy production from renewable resources: by 2050 the share of such resources as hydro-electric projects, wind, solar energy, etc., will move from the current level of 18% to 34%, which will lead to a pollution reduction in the range of 9% to 16% in CO_2. (OECD/IEA, 2006) Hydroelectric plants, which are considered the cheapest energy resource in some regions, have great capabilities for growth, particularly on a small scale. These power plants are considered to be the largest renewable energy resources, and each country should make the most of its maximum ability of water resources. The capital costs of these power plants are low.

The massive use of wind plants has become more attractive due to a drastic reduction in costs through the use of these resources. Since the cost of turbine construction per KW is lower as compared to other energy resources, it has been assessed as competitive. With regard to the advances of this technology, it is expected that the use of these turbines will increase rapidly. In some regions, this energy is seen as the second renewable resource. (OECD/IEA, 2004)

1.5.2.2 From a microeconomic point of view

There are many cases at the micro-level that have a great capability for efficient energy consumption. In many countries, the new buildings can save energy up to 80% more than the older ones. In England, for example, improving construction standards reduces the energy consumption to 60% in the period of 1965-2005. (Geller & Attali, 2005)

Using better isolation, ventilation and refrigeration systems can improve performance from 30% to 40%. The maximum attainable savings in lighting systems range from 30% to 60%. Industry and transportation sectors are also very important, since they consume major petroleum products and saving in these sectors is the fastest way to achieve energy efficiency and prevent pollution emissions. (OECD/IEA, 2006)

1.5.3 Improving energy efficiency

Energy efficiency provides a unique opportunity to raise some important challenges relating to energy, such as energy security, climate change, and economic development. Existing experiences show that efficiency in energy has considerable benefits. Improving energy efficiency, which is the result of energy management, can be achieved in different ways in the fields of production, distribution and consumption:

- Better insulation of buildings, using improved equipment, and improving efficiency and modernization in the industry sector are considered the best of such measures. (World Bank Staff, 2006) According to the estimates of the IEA (International Energy Agency), energy consumption in building and transportation industries can be reduced to 33% by 2050. The lighting sector in developing countries has great capabilities for energy saving and quality improvement. The growth of lighting consumption in these countries is double (3.6%) the growth in industrial countries (1.8%). (World Bank Group, 2007) (p. 17)

- Postponing the need to build new power plants and fuel saving, energy efficiency can reduce the demand for financial resources in developing countries, and also operation and maintenance costs. Companies improve their financial performance and take advantage of benefits by creating effective competition in the private sector. Less energy consumption leads to public interest since it reduces pollution and improves working conditions by providing better lighting and clean air.
- Preventing network transmission casualty. Network transmission casualty is very high in developing countries. In Asia, for instance, in terms of the discrepancy between produced and consumed electricity, the total rate of network casualty is almost 43%; in Latin America it is about 51%, which are unbelievably high numbers. (Lowery, 2006) (p. 8) In this regard, using appropriate conductors and equipment which have less heat production and, as a result, less energy casualty would be influential. The technical casualty rate in the USA is 6% to 7%, this figure is 3 to 5 times more in developing countries. The fields of improving energy efficiency in different sectors are shown in table 3.

Sector Name	The opportunities for energy efficiency
Building	Overall building design, better insulation
Industry	Industrial progress, recycling waste heat
Cities and municipalities	Regional heating system, using energy combination, efficient lighting system in passages
Agriculture	Using pumping system and advance irrigation
Energy Supply	New power plant: integrated cycle, integrated gasification combined cycle (IGCC), and using other advance combustion systems. Renovating current establishment: in the field of energy production including water plants
Transportation	Advanced petrol and diesel engines, extensive urban transport systems, using CNG (Compressed Natural Gas)
Households	Using efficient equipment

Table 3 - Opportunities for energy efficiency in important consumption sectors.

- Introducing and using standards and energy labels on energy consuming appliances which have been invented and executed by the Collaborative Labeling and Appliances Standards Program (CLASP). These measures were so effective that it has been said that investing in standards and labeling is more effective than investing in energy production. From 1999 (when the organization was founded), 21 cases of new standards have been introduced, which are executed in 54 countries. According to estimates, using these standards have prevented 90 TW/H energy and 86 million tons of carbon dioxide emission by 2014. For example, China has managed to save 33.5 TW/H or almost 9% in the household electricity sector. (Ruteh, 2011)(p. 168)

With regard to considering climate change, energy efficiency would be the best, cheapest and fastest way to reduce the destructive effects of it in the next decades.

1.5.4 Environmental consideration of energy demand

According to the scenario about rising energy demand in the period between 2005–2030, carbon dioxide will increase by 70% and, compared to its current level of 22 billion tons, it will reach 38 billion tons. (Clini & Ortis, 2003) The increasing amount of CO_2 and other greenhouse gases trapped in the atmosphere due to using fossil fuel results in increased temperatures and climate changes. Figure 2 shows the process of carbon dioxide emission over the past years until 2030 in different regions in the world. Due to the mentioned changes in the energy market, the classification of polluting geographical regions in the word will also change.

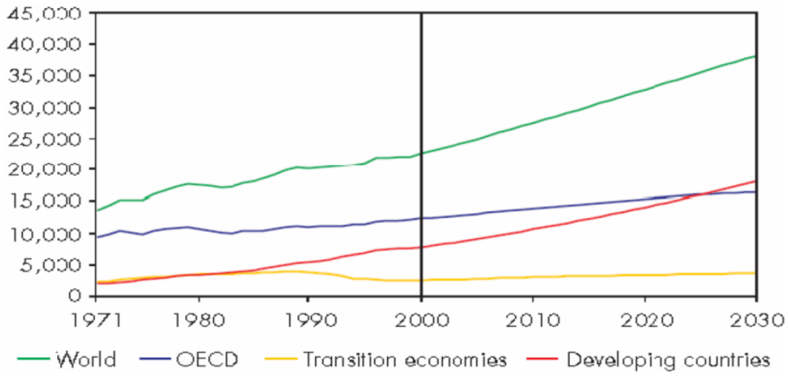

Figure 2 - Energy-related CO_2 emission in the world (million tons). (Ruteh, 2011) (p. 163)

On a historical basis, OECD countries have been the biggest producers of greenhouse gases. In the year 2000, these countries produced 55% of carbon emission in the world. After the year 2000, the share of developing countries rose to 47%, becoming known as the areas where the heaviest volume of pollution was released, while OECD countries' share decreased to 43%.

Unlike the past three decades, the emission of pollutants will grow faster than energy consumption, and this issue highlights the necessity of careful and efficient planning in energy management and energy consumption by all countries to sustainably maintain and manage the environment. With the help of energy management, which leads to efficient use of fossil fuels in industry, households, and transportation, and changing the conditions toward using renewable energies, the amount of pollutants can be controlled and reduced. In fact, energy consumption is increasingly affected by environmental regulation, and the behavior of consumers can change according to their awareness of the environment. Most of these changes have happened as a result of the increasing influence of NGOs with regard to the environment, as well as serious efforts to prevent the destruction of the ecosystem and human health, and will, hopefully, end in a stronger regulation to reduce pollution of the ecosystem. All these issues point human knowledge to the idea of optimum use of energy, its management, and increased efficiency in consumption. (Ruteh, 2011) (p. 163)

1.5.5 Role of government in creating a stable policy encouraging low-carbon energies and effective energy efficiency

Fortunately, in recent decades, and particularly in the last several years, policy makers have understood the importance of energy security and the environmental impacts on efficiency.

New energy technologies might be more expensive than the current equipment and, as such, if there is no economic incentive, no significant results will be achieved. There are different ways to achieve these goals in the forms of national or international plans, as well as through fiscal and regulatory measures. Both developed and developing countries need such incentives. Furthermore, developed countries play a significant role in helping developing countries to improve and transmit technical knowledge, expanding capacities and research, and developed cooperation.

In their technical and economic support, international organizations and institutions have declared making energy consumption efficient as one of their priorities that matches the development goals in the third millennium, and, by providing financial and technical facilities, have taken serious steps on this path. An international bank group, one of these institutions, has invested up to 1.3 billion dollars in 40 countries from 1990 in the field of energy efficiency. (Ruteh, 2011) (p. 169)

IFC (International Finance Corporation) has also considered measures for private sector energy investment. So, from a national scale, governments' roles and responsibilities are more fundamental, and they have to execute coherent policies and encourage society to use existing experiences. These measures can be different for every country's state and its priorities.

1.5.6 Conclusion

With regard to global energy market transformation in future decades, and the fact that the major share of global energy will be consumed in developing countries, with rapid growth in some energy consumption sectors, it is necessary that all countries, particularly developing countries, put developmental policies in energy management, and pollution reduction on their agenda. Energy has significant characteristics which, in the case of crisis, can make the greatest impact on other sectors. This impact does not only include economic sectors, but it also affects social, health, and, more importantly, the environment. As a result, energy management is the central issue for creating sustainable energy, because with sustainable energy, we will have sustainable development.

The following can help us in making energy efficiency plans for achieving sustainable development along with energy management (Ruteh, 2011) (p. 170):

- Improving energy efficiency is the main factor for creating wealth in countries.
- Improvement in energy efficiency and energy management depends on governments' attitudes.
- Energy efficiency is the largest, cheapest and fastest way to prevent the destruction of the environment.

Protecting the climate and the reduction of greenhouse gases are urgent issues for our society. The key to solving these issues successfully is the efficient and sustainable use of energy. Energy efficiency is very important for households as well, because the energy supply for households is much bigger than the energy supply for traffic and industry (Messe Frankfurt, 2019).

Chapter 2 – Literature Review

The following literature review focuses on the published information concerning our topic, within a certain time period. The data for the literature review taken from journals, working papers, newspaper articles, government reports etc., are classified into two sub-sections: a) Literature Review on Ecological, Energy, and Carbon Footprints; b) Literature Review on two national strategies of the Republic of North Macedonia concerning sustainability and energy development: the National Sustainable Development Strategy of the Republic of North Macedonia (NSDS RNM) and the National Energy Development of the Republic of North Macedonia (NEDS RNM).

2.1 Literature review on Ecological, Energy, and Carbon Footprints

2.1.1 Ecological Footprint

2.1.1.1 Origins of the Ecological Footprint

The Ecological Footprint has stimulated an enormous amount of academic and policy attention since its initial start in the early 1990s. It has been reported (Van Den Bergh & Grazi, 2010) that the Institute for Scientific Information (1^{st}) Web of Knowledge delivered over 500 journal articles for 'Ecological Footprint', with an increasing trend from 2001 to 2008, while the Google search engine delivered more than 2 million hits, and Google Scholar more than 14,000 hits. This is an impressive rate of activity since the first academic article on the concept of the Ecological Footprint was published in 1992 (Rees, 1992). As this topic is an area of rapid innovation, some of the references exist only as web pages, not as works in peer-reviewed publications. Initially, Professor William (Bill) Rees, the name most frequently associated with the Ecological Footprint, together with Mathis Wackernagel (his former PhD student), , did not use the said term, but instead referred to a 'regional capsule' and used the phrase 'appropriated carrying capacity' (Rees, 1992). It was only later that Rees coined the term 'Ecological Footprint', when criticizing the economic models of resource use, arguing that more attention should be paid to the land area required by urban areas to sustain themselves. (Collins & Flynn, 2015) (p. 1)

2.1.1.2 Advancement of the Ecological Footprint

In this section we will briefly introduce two key concepts that have frequently been presented as alternatives to the Ecological Footprint, namely, the concepts of Environmental Space and Ecological Rucksack. Neither has gained the popularity of the Ecological Footprint (Opschoor & Reijnders, 1991); (Carley & Spapens, 1998). The concept of Environmental Space was most widely discussed in the Netherlands (Hille, 1997). Within these different methods there is a desire to ask whether current patterns of resource use are sustainable and equitable (Carley & Spapens, 1998)(p.70). For these approaches, the answer is clearly no, but they arrive at their conclusions in different ways.

The Ecological Footprint has had policy promoters who have defended its case. These promoters have been able to recommend the Ecological Footprint to a wide range of policy audiences and to develop it as a way of helping to improve the quality of decision making by ensuring that more attention is given to the environmental consequences of policies. (Collins & Flynn, 2015)(p. 3-5)

2.1.1.3 Policy Change and the Ecological Footprint

In this part we will explore how policy promoters identify policy problems and provide policy solutions. Policy promoters tend to share a number of characteristics, including the identification of an alternative policy or approach, and a desire to promote change; an insistence on credibility, such as scientific competence (the Ecological Footprint is promoted as a technically sophisticated model) or have the ability to speak on behalf of others (Wackernagel is the leading figure and founder of GFN, the network organization that promotes the use of the Ecological Footprint and standardizes its methodology) and, because of their credibility, policy promoters often have access to political and policy elites [for instance, Wackernagel has worked with the Environment Protection Authority Victoria in Australia (EPA Victoria), as well as with the United Arab Emirates (UAE) Ministry of Environment and Water]. (Collins & Flynn, 2015)(p. 6)

NGOs from around the world have invited Wackernagel and given him an opportunity to present the Ecological Footprint repeatedly to audiences of experts, civil servants, scientists, and others involved in the environmental policy and advisory field (Boezeman, et al., 2010).

Boezeman and his colleagues point out that experts, bureaucrats, academics and advisors rework scientific insights into new policy concepts, of which the Ecological Footprint and its variants, such as the Energy Footprint and the Carbon Footprint, make good examples, based upon the work of Kingdon (Kingdon, 1984). They distinguish a number of features that a policy concept may hold. First, and perhaps one of the most important for our purposes, is the quality of the scientific knowledge behind the concept. GFN has recognized the importance of scientific validity and has sought to demonstrate the strength of the Ecological Footprint through publications in peer-reviewed scientific journals and standardizing the methodology. Critics of the Ecological Footprint have similarly recognized the claims that can be made by a scientifically valid concept, and have sought to compromise its method (Van Den Bergh & Verbruggen, 1999); (Lenzen & Murray, 2001); (Ferng, 2002); (Van Vuuren & Smeets, 2001). Second, there is the compliance between the normative claims made by a concept, and existing value systems. Central to the Ecological Footprint are claims of resource limits and a fair share of the Earth's resources. At a time of widespread prosperity in the West, rethinking models of economic growth (Anderson & M'Gonigle, 2012); (Beder, 2011); (Illge & Schwarze, 2009) can have some reconsideration. The start of the recession in 2008 makes more traditional models of growth more attractive, and arguments for 'sustainable growth' become important. A third feature is the attractiveness of the Ecological Footprint with the public and the policy makers (Hannigan, 2006). (Collins & Flynn, 2015)(p. 8-9)

2.1.2 Energy Footprint

The Energy Footprint is viewed as a subset of the Ecological Footprint expressed in area gha units (Herva, et al., 2011). It was equated to the amount of forest land that would be necessary to absorb CO_2 emissions from fossil fuel combustion and electricity generation through the use of sequestration values for a world-average forest (Wackernagel & Rees, 1996). More recently the Energy Footprint was considered to be the sum of all those areas used to sequestrate CO_2 emissions from the consumption of non-food and non-feed energy (Čuček, et al., 2012). Although humanity is being exposed to the accelerating energy-related environmental issues, the Energy Footprint did not receive enough attention from Footprint users until Ferng focused, for the first time, exclusively on the analysis framework for it. Ferng’s initiative (Ferng, 2002) highlights the importance of the Energy Footprint independent of the Ecological Footprint in energy scenario analysis by using an input–output analysis (IOA) based framework. Over the past years, an expanding list of researchers has chosen to concentrate exclusively on the topic of the Energy Footprint (Palmer, 1998); (Stöglehner, 2003); (Wiedmann, 2009). Depending on updated data obtained from the Intergovernmental Panel on Climate Change (Core Writing Team, 2007), the calculation of the Energy Footprint has been revised with a fraction of approximately 30% of the total anthropogenic emissions for ocean uptake (Borucke, et al., 2013); (Monfreda, et al., 2004). Nowadays, more researchers prefer to explore and measure the Energy Footprint independently. Some initial objections to the original method in terms of how energy is accounted for have been partially overcome by the development of specific models or indicators, such as in (Kitzes, et al., 2009), or in (De Benedetto & Klemeš, 2009). Several sub-footprints have been generated, such as the Fossil Footprint, the Nuclear Footprint, and the Electricity Footprint (Čuček, et al., 2012), and (Stöglehner, 2003). Recently, some researchers called for a redefinition of the Energy Footprint as the sum of the whole area used to sequestrate CO_2 emissions from the consumption of non-food and non-feed energy (Čuček, et al., 2012). (Fang, et al., 2013)(p. 80)

2.1.2.1 Footprint family

Since there is insufficient literature focusing specifically on the Energy Footprint, we shall combine the Energy Footprint with a selection of Footprints that address similar aspects of sustainable and energy management issues into one integrated system. The key conclusions are that the Footprint family, which captures a broad spectrum of sustainability and energy management key issues, is able to offer a more complete picture.

Nowadays, Footprint indicators have become popular for researchers, consultants and policy makers, and the implications for sustainability and human well-being have been looked at from different perspectives with an increasing interest in similarities, differences, and interactions between some selected Footprints. Nevertheless, there is not yet a completely satisfactory and generally accepted Footprint that can simply represent the overall impacts of human activities as the "golden standard" indicator (Huijbregts, et al., 2010); (Rees, 2002). Therefore, it seems to be a natural step to move toward an integrated system of Footprint indicators. Following (Galli, et al., 2012), we refer to this as the *Footprint family*. The concept of a Footprint family has only been initially applied in that a very limited number of papers have dealt with it.

The term *Footprint family* was first advocated simultaneously and independently by Giljum (Giljum, et al., 2008) and Stoeglehner (Stoeglehner & Narodoslawsky, 2008). Some other studies have discussed similar topics without mentioning the said term; for instance (De Benedetto & Klemeš, 2009) designed a composite Footprint indicator as a single measure for the sustainability of a given option. Niccolucci developed an integrated footprint-based approach for environmental labeling of products (Niccolucci, et al., 2010). Herva reviewed a series of environmental indicators and proposed the Ecological and Carbon Footprints to be the most appealing indicators for enterprises (Herva, et al., 2011). Čuček presented a comprehensive overview of the Environmental, Social, and Economic Footprints that can be used to measure the three pillars of sustainability (Čuček, et al., 2012). Steen-Olsen used a MRIO (multiregional input-output) model to quantify the total environmental pressures due to consumption in the EU by calculating the Carbon, Water, and Land Footprints (Steen-Olsen, et al., 2012). Feng presented a critique of some of these integration schemes (Feng, et al., 2011). (Fang, et al., 2013)(p. 79)

2.1.2.2 Selection of indicators for creating a Footprint family

In principle, any two or more Footprint indicators can be seen as a Footprint family. The Ecological, Energy, and Carbon Footprints rank as the most important Footprint indicators in the existing literature. This is partially because they are in close relation with the three global concerns over threats to human society: food security, energy security, and climate security (Mason & Zeitoun, 2013). Their frequencies of occurrence in scientific literature show a similar trend of increasing popularity during the period of 1992–2002. Notably, the statistics of the Carbon Footprint began to increase in 2007 and they have even exceeded those of the Ecological Footprint since 2009. In this paper, we make a selection of Footprint indicators by combining the Ecological, Energy, and Carbon Footprints as potential members of a Footprint family. (Galli, et al., 2012)(p. 103)

2.1.2.3 Ecological Footprint vs. Energy Footprint

Many different Footprint-style indicators have been created and have become complementary to the Ecological Footprint during the last two decades, including the Energy Footprint (Wackernagel & Rees, 1996). It is undoubtedly true that the Energy Footprint has become the most important but disputed subject in the Ecological Footprint analysis. In most cases, the Energy Footprint is the largest contributor to the Total Ecological Footprint, composing a part of nearly 50%, or even much higher, on both a local and global level (Kitzes, et al., 2009); (Ewing, et al., 2008). In other words, the national or Global Ecological Footprint estimates are extremely sensitive to the methodological option for the Energy Footprint (Van Den Bergh & Verbruggen, 1999), (Ewing, et al., 2008). Furthermore, the measure for sustainability of a region is also determined by the amount of Energy Footprint rather than by that of the overall Ecological Footprint since the biocapacity is able to partially compensate for the Ecological Footprint without an Energy Footprint. That is why the Energy Footprint always results in the same amount of the Ecological Deficit. (Fang, et al., 2013)(p. 82)

2.1.2.4 Ecological Footprint vs. Carbon Footprint

The Carbon Footprint is technically close to the Ecological Footprint, and, in general, it is not expressed in terms of area, but rather in mass units (e.g. kg, t). This is exactly what the debate mainly focuses on. Some researchers view the Carbon Footprint as a subset of the Ecological Footprint, and pursue a further step of transformation from mass units to area units in order to achieve more value for making climate policy (Herva, et al., 2011); (Kitzes & Wackernagel, 2009). They believe that putting emissions into a spatial context is far more meaningful to the general public, and this also enables a comparison with other demands on biologically productive land (Cranston & Hammond, 2012); (Kitzes & Wackernagel, 2009). (Fang, et al., 2013)(p. 82)

2.1.2.5 Carbon and Energy Footprints as components of the Ecological Footprint

Today, the term "Carbon Footprint" is often used as shorthand for the amount of carbon (usually in tons) emitted by an activity or organization. The Carbon Footprint is also an important component of the Ecological Footprint, since it is one competing demand for biologically productive space. Carbon emissions from burning fossil fuel accumulate in the atmosphere if there is not enough biocapacity dedicated to absorb these emissions. Therefore, when the Carbon Footprint is reported within the context of the total Ecological Footprint, it is called the Energy Footprint. With the Energy Footprint, the tons of carbon dioxide emissions are expressed as the amount of productive land area required to sequester those carbon dioxide emissions. This tells us how much biocapacity is necessary to neutralize the emissions from burning fossil fuels.

Measuring the Carbon Footprint (Energy Footprint) in land area does not imply that carbon sequestration is the sole solution to the carbon dilemma. It just shows how much biocapacity is needed to take care of our untreated carbon waste and avoid a carbon build-up in the atmosphere. Measuring it in this way enables us to address the climate change challenge in a holistic way that does not simply shift the burden from one natural system to another. In fact, the climate problem emerges because the planet does not have enough biocapacity to neutralize all the carbon dioxide from fossil fuel and provide for all other demands. (Global Footprint Network, 2019)

2.1.2.6 Carbon Footprint and non-CO_2 emissions

The usefulness of the Carbon Footprint differs from the Energy Footprint and has been justified in two respects: first, it takes into account non-CO_2 emissions (e.g. CH_4, N_2O), of which the global warming potentials (GWPs) are much higher than that of CO_2 (Core Writing Team, 2007), and, second, the Carbon Footprint makes it easy to allocate the responsibility for global warming to consumers (Wiedmann & Minx, 2008).

The greater the GWP of a GHG, the more responsibility it should take on for increasing global temperatures. The metric is expressed in CO_2-equivalent mass units such as kilogram or ton (Ridoutt & Pfister, 2013).

The Carbon Footprint is defined as the total amount of CO_2 emissions caused directly and indirectly by an activity (Wiedmann & Minx, 2008), while it is more accepted that it measures the amount of greenhouse gases (GHGs) emissions across the life cycle of a process or product (Institute, 2011). The Carbon Footprint can probably be traced back to the global warming potential (GWP) (Høgevold, 2003). GWP is a widely used indicator, which represents the quantities of GHGs that contribute to global warming, considering a specific time horizon, such as 100 years. It has been long known that some GHGs, such as CH_4 and N_2O, whose GWP is much greater than that of CO_2, should be responsible for increasing global temperatures (Core Writing Team, 2007). Having recognized that

CO_2 plays a significant role in global ecosystem services, and has made the greatest contribution to climate change, the Carbon Footprint has been applied at a vast range of levels, such as individuals, products, manufactures, industries and countries. When evaluating at a sub-national level, especially at a product or process level, life cycle assessment (LCA) is highly recommended as an effective tool for quantifying the Carbon Footprint (De Benedetto & Klemeš, 2009); (Heijungs, 2010). (Fang, et al., 2013)(p. 81)

2.2 Literature review on two national strategies of the Republic of North Macedonia

2.2.1 Sustainable Development Strategy of the European Union

The general strategic priorities of the European Union in relation to sustainable development are reflected in a number of documents, among which is the Sustainable Development Strategy (SDS), which defines the frameworks of the concept.

The key concerns of the European SDS refer to environmental protection, social cohesion, economic prosperity, and commitment to international obligations.

2.2.2 National Sustainable Development Strategy of the Republic of North Macedonia

The Sustainable Development Strategy of the European Union was taken as a framework of the NSDS of the Republic of North Macedonia (National Sustainable Development Strategy of the Republic of North Macedonia). The Government of the Republic of North Macedonia introduced the National Sustainable Development Strategy in February 2008, in which it presents what should be done to ensure a balanced development of society.

The National Sustainable Development Strategy of the Republic of North Macedonia (NSDS RNM) (NSSD Project Team, 2008)(p. VI) consists of two parts: Part One, which contains the overall strategic framework (see Figure 7 in the Annex for Chapter 2), and Part Two, which contains the strategic basis for support. Its implementation is aimed at providing economic development which would be socially responsible and fair, acceptable for the environment, and which would rely on the basic postulates of civil society.

2.2.2.1 Diagnosis of sustainable development in the Republic of North Macedonia

This section provides a diagnosis for sustainable development in the Republic of North Macedonia. It is based on the Framework Sustainable Development Report and NSDS RNM Part II: Strategic Basis and Analysis presented in the Consolidated Findings, Conclusions and Recommendations. (Ministry of Environment and Physical Planning, 2009)(p. 13)

As far as sustainable growth is concerned, the Republic of North Macedonia benefits from having a developing economy, since its resources have not been over-exploited yet. As a result, the rich natural and cultural resources of the Republic of North Macedonia have still not been exhausted. All this, in the context of sustainable development, means that sensible steps and activities are needed in order to prevent and protect the environment with its natural and cultural heritage.

In brief, the comprehensive diagnosis of sustainable development in the Republic of North Macedonia can be defined as:

- An insufficiently developed awareness, understanding and commitment to sustainable development.
- Full commitment to EU membership at the national level.
- Rich natural and cultural heritage.
- High unemployment rate and the need to increase the employment rate.
- A need for significant improvement and strategic redirection of the health sector.
- A need for significant improvement and strategic redirection of the education sector.
- A need for strategic relocation in certain segments in the fields of energy, agriculture and forestry.
- A need for structured strategic planning in tourism, which is a sector of great potential.
- A need for significant improvement of the water supply system, wastewater treatment, and solid waste management.
- A need for significant improvement of the railway network.
- A need for strategic focus in the field of road planning and construction.
- A need for industrial development, in particular the development of small and medium-sized enterprises that play a significant role and require strategic reorientation.
- A need for complete organizational development and institutional strengthening in all areas of public life, including policy making, legal and regulatory frameworks, strategic planning, administration, monitoring and implementation.

2.2.2.2 Vision of the NSDS RNM

The vision of sustainable development in the Republic of North Macedonia was defined in the final draft of the NSDS RNM document (NSSD Project Team, 2008)(p. 85). According to this document, this part includes:

1. Economic vision, which starts from the need for accelerating economic growth, completing the process of transition toward a market economy, stimulating innovation and productivity, strengthening entrepreneurship, and preventing brain drain;
2. Social vision, which includes the reduction of poverty and the protection of the most vulnerable groups of the population, as well as ensuring a fair distribution of benefits from economic development among all segments of society;
3. Ecological vision, i.e. the necessity of preserving the environment, and sustainable management of natural resources, promoting synergy between development and preservation of the environment, and bearing in mind the right to a quality of life for future generations;

4. Ethical vision, which implies improvement of governance by capacity building of all actors (central government, local authorities, the private sector, and civil society), and promoting cultural vision, i.e. the necessity of preserving cultural diversity and identity, while strengthening the cohesion of the society as a whole.

2.2.2.3 The three pillars of sustainable development in RNM

Starting from the vision of sustainable development in North Macedonia, and the identification of issues and challenges in the areas of economic development, environmental and natural resources, and social development, the following initiatives and assignments have been established:

Economic	Environmental	Social
Macroeconomic developments	Protecting biodiversity and preserving natural values	Governance and public participation in decision-making
Regional development and employment	Waters	Education
Traffic	Air	Health
Tourism	Land	Equality and social protection
Agriculture and rural development	Forests	Culture and media
Energy	Environmental management system	Urban development
Industry	Spatial planning	
New technologies	Climate change and ozone layer protection	
	Waste	

Table 4 - Opportunities for energy efficiency in important consumption sectors.

For the purposes of our topic, we will consider only the aspect of Energy (from the economic pillar), which is further explained in detail in the NEDS (National Energy Development Strategy) of the RNM.

2.2.2.3.1 Energy

Energy production and consumption in RNM are linked with considerable negative impacts on the environment. Due to the fact that fossil fuel combustion is associated with major local and global environmental problems, there is significant potential for using energy from small hydropower plants and alternative sources.

The priority NSDS RNM assignments in the field of energy are the following: a rational consumption of electricity, a reduction of energy import by optimal use of available domestic resources, and, giving priority to renewable energy sources. Initiatives to accomplish these assignments include: reducing losses, implementing the energy efficiency strategy, establishing an energy efficiency fund, creating projects for increasing energy efficiency in all sectors, and, strengthening the energy information database. For these assignments, it is necessary to adopt the National Energy Development Strategy (NEDS), harmonize domestic regulations with the relevant EU regulations, and work on creating a more efficient framework (institutional, financial, and regulatory) for sustainable development. The inclusion of the private sector plays a vital role in this as well. There are also initiatives related to: maintenance, revitalization and modernization of the existing infrastructure; construction of a new capacity for energy production and consumption; giving priority to renewable energy sources; and, combined heat and electricity production (CHP). (NSSD Project Team, 2008)(p. 40)

2.2.3 Energy Management in the Republic of North Macedonia

2.2.3.1 The state of the energy sector in the Republic of North Macedonia

The production of electrical energy in the Republic of North Macedonia is mainly based on coal (lignite) with a relatively low quality. Approximately 80% of the locally generated electrical energy comes from the coal-fired thermal power plants, Mining Power Plants (MPP) Bitola and Oslomej, whereas the remaining 20% is mainly generated by hydropower potentials. An insignificant part of the electrical energy is generated through so-called new renewable energy resources such as solar, wind, geothermal and biomass waste energy. The 20% of energy generated from renewable energy resources is insufficient for the energy sector of North Macedonia to comply with the European energy practices, since the EU has planned 80-95% of the economy to be fossil fuel-free by 2050. (ACER, 2016) (p. 1)

2.2.3.2 National Energy Development Strategy in the Republic of North Macedonia

The National Energy Development Strategy (NEDS), which is currently undergoing revision, does not envisage any significant changes regarding the so-called de-carbonization measures in the energy sector, and because of that, it would be very difficult for North Macedonia to comply with the EU directions. Furthermore, it has been predicted that the energy sector will remain coal–based at least until 2035 (the NEDS covers the period of 2015-2035), because coal will have to be imported once the relatively small domestic resources are exhausted. Moreover, a new coal-fired thermal power plant is planned to be built, even though there will not be sufficient domestic coal for its life cycle (25-60 years). This will significantly contribute to further fossil fuel dependence, when such a tendency is avoided in developed countries.

Within the NEDS, the energy efficiency was planned to only reach a not very ambitious 9% increase by 2018, despite the compliance with the EU requirements to reach a 20% rate by 2020. It is inevitable to predict that the low energy efficiency will be one of the issues the Republic of North Macedonia will be faced with during the negotiations for accessing EU membership.

Another problem concerning energy efficiency is not having an energy efficiency fund, which, although it had been planned in the previous version of the NEDS, has not been implemented yet. Such a fund is necessary for improving household energy-efficiency, because the so-called “green” credits, currently offered by the banks, are rather inconvenient and do not stimulate the residents to improve their household energy performances. According to the “Calculator 2050” (Anon., 2015) model data, the average renovation rate is required to increase 2.5% annually in the period of 2020-2050 so as to reach an 80% decrease of the greenhouse gas (GHG) emissions by 2050.

Unfortunately, the NEDS takes into consideration the climate changes and the GHG emissions only on paper, but not in practice. Despite the fact that the energy sector is a major contributor to the GHG emissions in the Republic of North Macedonia, NEDS does not envisage measures for climate change adaptation and mitigation (Anon., 2019).

In the past period, apart from the GHG emissions, high air pollution with PM_{10} (tiny particles smaller than 10 micrometers) has been detected, for the presence of which it is the energy sector that is the greatest culprit. However, the NEDS does not take into consideration the emissions and their impacts, either concerning the citizens’ health or the economy sectors.

It is also noticeable that the NEDS lacks innovative solutions, such as: passive house stimulation; a solution for waste biomass collection for energy production; decentralized, local electrical energy production, and the like. In addition, there is an absence of technological development and incentives for innovations in order to meet the energy needs.

2.2.3.2.1 The problem with the NEDS adoption process

There is a tendency to avoid the public participation in its preparation, adoption and revision. Apart from the poor availability of information, there is also the practice of scheduling public discussions during holiday seasons and vacation periods.

The process of the adoption of the NEDS is rather problematic because the Parliament of the Republic of North Macedonia has not been consulted, although the NEDS is one of the most important strategic documents which has multiple impacts on the three pillars of sustainable development. Because of its significance, it is necessary to carry out exhaustive consultations with all key parties responsible for reaching decisions.

Outside the NEDS framework, there is a tendency of non-compliance with the Energy Community Agreement, especially in terms of the given deadline violations. At the moment, the Energy Community has four open cases referring to violation of the Energy Community Agreement for the

Republic of North Macedonia, and they are: the problem with postponing the liberalization of the energy market; the failure to adopt a National Action Plan for renewable energy resources; the failure to comply with the Directive for Sulphur content of liquid fuel; and, the failure to take part in the "8th Region" initiative for improving energy efficiency by preventing network transmission casualties in the region of South East Europe (Energy Community, 2019).

The Republic of North Macedonia has made a commitment to reduce greenhouse gas emissions by at least 30% by 2030. Since most electricity still comes from coal-fired power plants, one essential way to achieve this goal is to improve energy efficiency. So far attempts have been made to make schools and other public buildings more energy-efficient, to fight climate change, but also to offer cost-efficient and user-friendly alternatives. Unfortunately, the public-sector buildings in Skopje and across the country are poorly insulated, using outdated windows, roofs and fixtures that allow heat to escape in winter. Some UNDP (United Nations Development Program) research suggests that even a few low-cost measures can reduce energy spending by one-third, so the savings potential for municipalities is huge. (UNDP, 2018)(p. 12)

To demonstrate the synergy between modest costs and multiple benefits of energy efficiency, the UNDP has partnered with local authorities, both in Skopje and elsewhere, to modernize public buildings. One example is the 'Orce Nikolov' kindergarten in Karpoš, which was one of the first in the country to be renovated. Renovations co-funded by the UNDP helped reduce energy costs by 60%. Similar efforts were undertaken at other kindergartens and schools. As a result, over 2,000 children now enjoy warmer classrooms in the winter. New insulation, windows, facades and roofing quickly generated sufficient annual savings on energy, and the municipality was able to afford the running costs for a new monitoring station.

By rehabilitating these public buildings, the municipality not only reduced the greenhouse gas emissions associated with inappropriate energy use, but it also saved money. These funds went back into municipal budgets and were used for other educational purposes, such as school supplies, or for other public services, such as healthcare.

2.2.3.3 Tackling air pollution

Work to reduce harmful greenhouse gas emissions goes hand in hand with efforts to eliminate air pollution. Skopje has emerged as one of the most polluted cities in Europe, and household heating is one of the main culprits, accounting for around 32% of these harmful pollutants. Air pollution and smog is the major issue. Air pollution is blamed for some 1,300 deaths a year in Skopje, with a high risk for people with chronic diseases, children, and the elderly. Fighting air pollution will not only strengthen progress on climate change, it will also help ensure well-being for everybody, in line with the Sustainable Development Goals.

2.2.3.4 What is the best way to fight air pollution?

A recent UNDP survey of 5,044 households in North Macedonia revealed that only 21% of the citizens are connected to central heating, whereas 45% heat their houses by burning wood. Wood-burning is one of the most polluting forms of heating, and it significantly increases the incidence of chronic respiratory disease for those living in wood-heated homes.

Some key findings from the UNDP survey from Nov 7, 2018 (UNDP, 2018)(p. 12) are the following:

● 85% of households in rural areas of Skopje heat their houses with wood-burning stoves;

● One-third of respondents admitted that they (or their neighbors) use harmful substances like wood scraps, plastic waste and even rubber (often found from construction waste or nearby garbage bins) for heating;

● 40% stated that their choice of heating system is based on the monthly bill, while only 1% based their decision on the pollution generated;

● 92% of households lack proper insulation, especially for roofs and windows;

● 317,000 tons of wood are burned for heating in Skopje each year — the equivalent of every tree on Mount Vodno, the nearest mountain that towers over the capital.

Understanding the socio-economic roots of the air pollution problem in Skopje is key to finding solutions. The UNDP, in partnership with national and local authorities, plans to support and encourage the public to use high-efficiency pellet-burning stoves, promote insulation and other energy-efficient solutions, and provide incentives to make use of the central-heating network.

Inefficient energy systems have led to poor health conditions, inadequate access to education or insufficient sources of income, while more efficient and renewable systems helped to make better progress and mitigate climate. Understanding the main causes for pollution will enable the public to tackle the air pollution problem more effectively. (Anon., 2019)

Chapter 3 – Research Methodology

In our research we have used the triangulation technique that combines both the quantitative and qualitative methodology, which implies using more than one method for collecting data on the same topic. This is one way to confirm the validity of the research through the use of a variety of methods for collecting data on the same topic, which involves different types of samples, as well as different methods of data collection. For the quantitative methodology we applied questionnaires, while for the qualitative methodology we used focus groups. (Marczyk, et al., 2005)(p. 17)

The model we developed for this purpose is called the *Ecological and Energy Footprint Analysis Model* (EEFAM), which offers metrics for comparing the Ecological and Energy Footprints with the available biocapacity.

As a research method we used the questionnaire, as well as grounded theory, where we collected various data from the Ministry of Environmental and Spatial Planning, and later processed that data using different software tools, such as Microsoft Excel, SPSS for Statistical data analyses, online questionnaires, and different social network platforms.

The Ecological and Energy Footprints can be measured for an individual, city, state, region, and the entire world. Also, an individual Ecological and Energy Footprint can be measured for a particular product, service, or process, based on their life cycle.

The Ecological and Energy Footprints of the individual provide insight into how everyday personal activities and habits have a harmful environmental impact and impede sustainable development. The Ecological and Energy Footprints of a person show what kind of individual or collective action can help in reducing our harmful influence.

The Ecological and Energy Footprints of a person are measured by a personal index calculator. The personal index calculator sets up a series of simple questions and then calculates how much land, in global hectares, is needed to support our lifestyle.

For the purposes of this research, the *Footprint Calculator* survey is used, which consists of data needed to calculate an Ecological and Energy Footprint. The survey is applied to a sample of 70 respondents, who participated in the case study. The participants are first-year students from the Department of English Language and Literature at the 'Blaže Koneski' Faculty of Philology (UKIM) in Skopje, 35 of whom are male, and 35 are female.

The survey consists of 27 multi-response questions. The answers are related to the respondents' consumer habits and lifestyle. The survey questions concerning the respondents' basic needs are categorized into the following four consumer areas or categories: food, housing (an object that includes the use of energy), products and services, and transport (personal and public transport).

The responses from the survey as data are entered, separately for each respondent, in an internet calculator created by the Global Footprint Network (GFN), the so-called Footprint Calculator.

The answers are calculated by the calculator in equivalents of the Ecological and Energy Footprints (global hectares, accepted as an international standard), and are statistically analyzed in Excel.

3.1 Global Footprint Accounting

The calculation of the Ecological Footprint is based upon six fundamental assumptions:

1. It is possible to quantify and monitor the greatest part of the total amount of resources consumed by humans, and the waste generated in that process.
2. It is possible to measure a significant part of the flow of these resources and waste, in light of the biologically-productive surfaces necessary for their food. The resources and waste flows not subject to measurement are excluded from these estimates, which leads to a systematic decrease of the Ecological Footprint's real values.
3. The grading of all surfaces according to their bio-productivity allows for the different types of surfaces to be transformed into a common unit, called the global hectare, which is one hectare of the average global bio-productivity.
4. Because this global hectare represents the identical amount of bio-productivity in any given year, it can be used as an all-inclusive indicator of the Ecological Footprint and biocapacity.
5. The human needs and demands, seen through the Ecological Footprint, may be directly compared to nature's ability, that is, biocapacity, if both factors are expressed in global hectares.
6. The surface needed to answer these demands may actually exceed the available surface, when the demands toward a certain ecosystem overshoot its regenerative capacity. (EASD Team, 2013)(p. 12)

3.1.1 Sound Methodology

The methodology for the Ecological Footprint is detailed but not too complex. Data inputs are from publicly available national, international and private organizations. Weaknesses in this pioneering attempt have been admitted, many have been corrected, and others are being addressed with further research.

To elaborate in detail on the methodology and the equations for the Ecological Footprint accounting goes beyond the purpose and scope of this particular thesis. However, we will here mention the two basic models of Ecological Footprint Accounting:

3.1.1.1 The Complex Model (top-down approach)

The complex model is used for the accounting of the National Ecological Footprints, which are based on national data, and per capita. The aim of this analysis is to include all social activities into the equation. By this approach, the final Ecological Footprint (the one after the total consumption) is calculated, which is why it is called the Ecological Footprint of Consumption. All energy consumed, and all resources taking a part in the production processes and services, together with the generated waste, are viewed as ecological rucksacks of consumed products and services. The production processes are excluded from this equation, because it would only lead to double counting, yielding insubstantial results.

3.1.1.2 The Component Model (bottom-up approach)

The component approach is used for the accounting of the Footprint for cities. Through this approach, the Footprint of various activities can be calculated in advance. This model is also used for production analyses, since not all products are consumed locally, which partially excludes the problem of double counting, while local production remains a very important issue in the local decision-making policies.

The main difference between these two models is that they use different input data. The Complex Model uses the national trading and energy consumption data, whereas the Component Model uses local and life-cycle studies data. (EASD Team, 2013)(p. 13)

In the future, attention will mainly be focused on software solutions enabling quick calculations of the approximate values of the Ecological Footprints, for educational purposes.

During the work on the project, two basic software solutions for the calculations of the Ecological Footprint have been identified:

1. On-line software – available on certain internet sites, enable a quick and clear accounting of the Ecological Footprint;
2. Software that demands purchase.

3.2 The Calculation Methodology

The calculation methodology of the Ecological Footprint is prepared by the international organization known as the “Global Footprint Network” (GFN). This organization redefines and corrects Ecological Footprint calculation methodology on a yearly basis. There is no one specific Ecological Footprint calculation methodology; however, present methodologies are similar.

Generally speaking, the Ecological Footprint is calculated using formulas 1 and 2 (Ewing, et al., 2008)(p. 3):

$$ai = \frac{ci}{\mathrm{yi} \times \mathrm{F} \times \mathrm{Ef}} \quad (1) \qquad\qquad Fp = \sum_{i=1}^{n} ai \quad (2)$$

where: a_i – Ecological Footprint of each element;
c_i – annual consumption of the element;
y_i – land productivity or output of each element (kg/ha);
F – yield factor;
Ef – equivalence factor;
F_p – total Ecological Footprint for a population.

The first formula (1) is used for the calculation of each component of the Ecological Footprint needed for the calculation of the Ecological Footprint. In other words, the Ecological Footprint of each component (for instance, field of grain) is calculated by dividing the annual consumption of the element by the productivity of the land (component output kg/ha), and this ratio is multiplied by the yield factor *F* and equivalence factor *Ef*. These factors are used in the transforming of land into global hectares. The second formula (2) is the sum of the Ecological Footprint of all calculated components, which shows the total Ecological Footprint. As mentioned above, the sum of the Ecological Footprints of all the components constitutes the total Ecological Footprint of the population at hand.

Generally speaking, the Ecological Footprint is a negative ecological indicator, while the other Ecological Footprint related indicator – biocapacity (BC) – can be perceived as a positive ecological indicator. Biocapacity is the capacity of the land's biosphere to produce renewable resources. Generally, we can say that the Ecological Footprint represents the needed resources to meet the needs of the people (their demand), and the biocapacity of the land is the ability of the land to create the resources (supply). Biocapacity of the land or a certain territory, as well as the Ecological Footprint, is measured in global hectares (gha). The biocapacity of land is calculated based on the following formula (Ewing, et al., 2008)(p. 3):

$$BC = S \times F \times Ef \qquad (3)$$

where: *BC* – biocapacity of the land (territory); *S* – area; *F* – yield factor; *Ef* – equivalence factor.

As seen from the third formula (3), the biocapacity of the land is calculated by multiplying a certain land area by the yield factor *F* and the equivalence factor *Ef*. This is the calculation of a certain land area expressed in global hectares. This expression shows how many renewable resources this land area is capable of creating. Separate indicators of the Ecological Footprint and biocapacity cannot present a country's or a certain region's complete evaluation in an ecological sense since separately they reflect only a one-sided perspective. These indicators should be valued in the complex manner by comparison. This opens up possibilities to evaluate whether a given country is an "ecological lender" or an "ecological borrower".

The Ecological Footprint illustrates both how much and who uses natural resources according to geographical and social position. The Ecological Footprint also shows the dominant areas of humans and wild life, and it explains the correct use of the natural resources, which helps the decision-makers to formulate social and environmental protection, political norms and aims more precisely.

3.3 Metrics and Statistics

Sustainable development is necessary, but without any measurable proof such a claim can hardly attract any attention. Only clear metrics can help this concept turn into an argument based on empirical facts. The first step in achieving sustainable development is to collect information on the extent of mankind's capacity of natural resources; how much we need, and how much of the natural resources we use up. The method developed for this purpose is called the *Ecological and Energy Footprints Analysis*. The Ecological and Energy Footprints give evidence of human consumption of natural capital, while the Ecological and Energy Footprints Analysis offer metrics for comparing the Ecological and Energy Footprints with the available biocapacity.

To obtain Ecological and Energy Footprints, a large quantity of data is used from public databases, such as: the Food and Agriculture Organization of the United Nations (UN FAUSTAT); the Organization for Economic Cooperation and Development (OECD); the International Energy Agency; the International Climate Change Panel (IPPC), and others. (Global Footprint Network, 2006)

3.3.1 Expressing the Ecological Footprint

The Ecological Footprint is usually expressed in global hectares (gha), or by the number of planetary equivalents. A global hectare is a hectare whose size is standardized so that it represents the average biological productivity of all land and waters on Earth in a given year. The planetary equivalent represents the number of planets, the size of the Earth, which would be required to provide life on Earth if each person lived as an average inhabitant.

When we say that the Ecological Footprint is measured by a global hectare, this means that we calculate how much area in hectares we need to meet our basic needs for: food production, housing, energy, products, services, transport, and waste disposal. The Ecological Footprint actually shows how we live. So, we turn all production, consumption, and waste management into hectares. When we talk about calculating the Ecological Footprint, then we take into account only the bio-productive areas of the planet, that is, those that we really use for our needs, i.e. those we leave our Footprint on.

Accordingly, we can define the Ecological Footprint as the necessary area in which biomass can produce enough energy and material to make up for human consumption by using the photosynthesis process.

The value of the Ecological Footprint varies throughout the year as it depends on consumption, production efficiency, and international trade. It is a good comparative indicator when it comes to the other indicator of sustainable development - biocapacity.

The Ecological Footprint is a measure of human demands toward the ecosystems of the Earth. Basically, it is a comparison of mankind’s needs with the regenerative capacity of the planet regarding the surface of the biologically-productive land, and the measures necessary for providing renewable resources and sustainable waste management. Accordingly, we can distinguish several constituents of the Ecological Footprint from the consumer components’ aspect. (Global Footprint Network, 2003-2019)

3.3.2 Ecological Footprint Standards

Standards have been established by the GFN Standards Commission, consisting of scientists and experts dealing with the Ecological Footprint from around the world. The standards serve to provide reliable results in surveys carried out throughout the Footprint Community that are concerned with studying the Ecological Footprint.

The Footprint Community is in line with the standard relating to greenhouse gas emissions (GHG emissions) associated with products and services, under the name 14067-Carbon Footprint of Products. The compilation of this standard is based on pre-existing standards: Life Cycle Assessment Standard (ISO 14040/44); Standard for measurement, quantification and reduction of gases with a glasshouse effect (ISO 14064); Eco-label and declarations Standard (ISO 14025); and, ISO 14067 - Carbon Footprint of Product, which provides further regulations for the standardized quantification of greenhouse gas emissions.

According to the national standardization organization, the ISO 14067 standard includes two parts:

a) Assessment and quantification
    - ISO 14067-1. A Carbon Dioxide Footprint of a product intended to measure the Carbon Footprint, as well as to control and monitor the process of reducing GHG emissions, and
b) Communication

- ISO 14067-2. The Carbon Dioxide Footprint of a product intended to coordinate the methodologies for the transmission of Carbon Dioxide Footprint information;
- ISO 14040/44. The LCA (Life Cycle Assessment) provides an important basis for the quantification part, while the communication part is based on the eco-label and declaration standard (ISO 14025);
- ISO-14064 Standard (GHG emissions calculation and verification) provides tools and guidelines for assessment, reduction, and trade in GHG emissions. (Lukić, 2011)(p. 3)

There is a practice and rule for applying the rules of this standard when calculating the direct amount of carbon dioxide produced by airplanes while flying.

In the field of protection from greenhouse gas emissions, certain subventions have been implemented globally. More precisely, quotas (or so-called "offsets"), which are equivalent quantities of carbon dioxide that can be emitted during the year, are allocated to air carriers. The air carriers are granted 80% of quotas (possible emissions) free of charge, while the remaining 20% are on the market at a certain price. Air carriers are allowed to sell a part of their quotas if they estimate that the full quantity will not be needed. This principle allows airlines that have first installed certain carbon dioxide emission reduction systems to be rewarded with the money from the sales, while organizations that have not yet done so are fined by paying for additional quotas because the initial 80% were not sufficient. The same principle of quota trading can be used for any product by applying the Ecological Footprint if the Ecological Footprint is calculated for that product. The Ecological Footprint is equivalent to bio-productive land, water or carbon dioxide, depending on the measured Footprint, so the company can buy an equivalent quota of the Footprint and declare the product environmentally-neutral.

If certain financial subsidies are carefully monitored in this area, great success may be achieved, where the benefits would be mutual, both for the manufacturer and for the buyer. The manufacturer would benefit from the use of new production technology that would sparingly use the resources, then by selling quotas, and eventually labeling a product suitable for marketing purposes. Considering the growing product offer and the growing concern for environmental problems, the trend has become a popular choice in Green Consumerism and Ethical Consumerism in recent years, which tells us that consumers are interested in buying products that are labeled Ecologically-Neutral. Applying ISO standards in the field of the Ecological Footprint helps to avoid problems by comparing the results of several different organizations that carry out the analysis, and establishing clear and uniform communication. Methods of measuring the Ecological Footprint may vary among the organizations that apply it. Some organizations, together with the Ecological Footprint, calculate most of the greenhouse effect emissions, some only with carbon dioxide, some following the entire Life Cycle Assessment Process (LCA), while some do not recognize the waste management phase in measuring the Footprint of a product or service, and so on. In this case, ISO standards help to establish clear boundaries when performing the analysis. (Lukić, 2011)(p. 4)

3.3.3 Who / what can be measured by the Ecological and Energy Footprints?

As it will be mentioned later (see *Different levels of Ecological Footprint*, page 45), everyone uses the natural resources on which all the inhabitants of the Earth depend. The Ecological and Energy Footprints can be measured for:

- Person
- City
- State
- Region
- The entire world

Also, individual Ecological and Carbon Footprints can be measured for a particular product, service, or process based on their life cycle. (Lukić, 2011)(p. 2)

3.3.4 Why did we choose to measure the Individual Ecological and Energy Footprints?

The Ecological and Energy Footprints of a person provide insight into how everyday personal activities and habits have a harmful environmental impact and impede sustainable development. The Ecological and Energy Footprints of a person show us what kind of personal or collective action we can undertake to mitigate our harmful influence.

3.3.5 How are the Individual Ecological and Energy Footprints measured?

The Ecological and Energy Footprints of a person are measured by a personal index calculator. The personal index calculator sets up a series of simple questions and then calculates how much land in global hectares is needed to support our lifestyle.

3.3.5.1 Global hectare (gha)

A global hectare (gha) is a measurement unit for quantifying the Ecological and Energy Footprints of people or activities, as well as the biocapacity of land and water surface on Earth. One global hectare represents the average productivity of all biologically-productive areas of the country (measured in hectares), in a given year.

In **2014**, there were **12.2** billion hectares on biologically-productive land and water surface. If this is divided by the number of living inhabitants in that year (**7.3** billion), it yields **1.7** global hectares per capita. (GFN, 2019)

Global hectares are accepted according to internationally accepted standards for equivalence and correction. One hectare has 10,000 square meters, or has an approximate size of a football stadium, i.e. area of a square section with dimensions from 100 by 100 meters.

3.3.6 Steps in making metrics and statistics

For the purposes of this research, the "Footprint Calculator" questionnaire was used, which consists of data needed to calculate a Personal Ecological Footprint. The questionnaire was applied to a sample of 70 respondents - students from the first year at the Department of English Language and Literature at the 'Blaže Koneski' Faculty of Philology (UKIM) in Skopje. 35 male and 35 female examinees were surveyed. The questionnaire was conducted on November 21, 2018.

3.3.6.1 Description of the sample

The questionnaire consists of 27 multi-response questions. (See *Annex for Chapter 6* on page A19) The answers are related to the consumer habits and lifestyle of the respondents. The survey questions are categorized into the following four consumer areas or categories, covering their basic needs:

1. Food
2. Housing (an object that includes the use of energy)
3. Products and services
4. Transport (personal and public transport)

Such a division provides a clear picture of the lifestyle habits of the respondents.

3.3.6.2 Description of the method

We received the responses from the questionnaire as data, separately for each respondent, in an internet calculator created by the Global Footprint Network (GFN), also known as the Footprint Calculator.

The GFN is an organization that aims to develop and raise awareness of our understanding concerning the Ecological Footprint. The GFN online calculator is available on the website http://www.footprintcalculator.org/. The answers are calculated by the calculator in equivalents of the Ecological Footprint (global hectares, accepted as an international standard).

3.3.7 Ecological Footprint components used for the Calculator

The calculator's result is based on six components of the Ecological Footprint that relate to the use of land types. They are:

Built-up land - land used for infrastructure and construction.

Forest land (forest products) - land used for building timber and carpentry.

Crop land - land used for growing nutrients.

Grazing land - land used for breeding animals for meat and meat products, dairy products, leather, and wool.

Fishing grounds - fish and saltwater fisheries for marine and freshwater products.

Carbon uptake land (forest land for CO_2 absorption) - forest land is indispensable for the absorption of CO_2 emissions from the combustion of fossil fuels. (Global Footprint Network, 2019)

3.3.8 Methodology of data analysis

Statistical and descriptive methods are used for data analysis. The statistical method was applied to show the attitude of the respondents, provided in percentage and in number, while the descriptive method was used to explain the results obtained.

In order to obtain accurate statistical results, Microsoft Office Excel 365 was used. The same program was used for data collection, with arranged columns for each question separately, using the Vlookup, Countif and Averageif functions, which help to show the number of each index separately from the total number of responses, i.e. indexes. The results are presented in tables, where the number of respondents is shown, as well as the percentage referring to the corresponding response. In the end, the data is shown in graphical charts that are provided to compare the responses, as well as to illustrate the statistical results.

With the descriptive method, the results are presented with explanations and conclusions derived from the conducted research. (Marczyk, et al., 2005)(p. 209)

Chapter 4 – Case Study Analyses

Chapter Four is the longest chapter and it consists of three parts. In the first part, the following topics are discussed: the concept and general points of the Ecological Footprint, biocapacity, ecological deficit, ecological overshoot and the Human Development Index. The second part is concerned with different levels of the Ecological Footprint, its limitations, as well as future directions, and, the third part deals with the Energy Footprint, which will be considered from two aspects: as an indicator of sustainability and as an indicator of energy management.

4.1 Ecological Footprint

The term "Ecological Footprint" dates back to the early 90s of the last century. Mathis Wackernagel, a Swedish student at the University of British Columbia in Vancouver (Canada), and Professor William Rees created the notion of the Ecological Footprint (Anon., 2003-2019) while working on Wackernagel's doctoral dissertation in 1994. Mathis Wackernagel is today the president of the international, non-governmental, non-profit organization Global Footprint Network (GFN), which is engaged in developing and promoting metrics for managing sustainable development.

4.1.1 Global Footprint Network

The Global Footprint Network (Anon., 2003-2019) (GFN) is an international research organization which was the first to introduce the method of calculating ecological debt. The GFN was established in 2003, and is based in Geneva. It calculates the Ecological Footprint in over 200 countries (including the Republic of North Macedonia) using data from previous periods that go back to 1961. The Global Footprint Network promotes a sustainable economy by applying the method of calculating the Ecological Footprint, which enables a quantitative presentation of sustainability trends. It has more than 70 partners and, together with its partners, this network coordinates scientific research, develops methodological standards and prepares calculations that enable national resources to be developed and assessed within each country's biocapacity. The Central Data Group calculates the global Ecological Footprint and biocapacity of more than 200 nations from 1961 to the present day (usually with a three-year delay due to data availability).

In the narrow sense, the Ecological Footprint measures human needs for natural resources by linking them to bio-productive land, including: built-up land, forest land, crop land, grazing land, fishing grounds, and carbon-uptake land.

4.1.2 Sustainable development and the Ecological Footprint

By itself, the Ecological Footprint does not say much about sustainability, but, when comparing it with the capabilities of the planet, we get a clearer picture of whether the development is actually sustainable, and what its critical points are. A critical point refers to the specific requirements that are found to be the most prominent in the creation of the Footprint. If it is found that the Ecological Footprint is bigger than the country's biocapacity, such a condition is considered unsustainable, and we have *ecological deficit* (or, *ecological overshoot*). If the biocapacity of an area exceeds the population Footprint, we have *ecological reserve*.

The acceptance and application of the Ecological Footprint as one of the indicators of sustainability is widespread. Several countries (Switzerland, Japan), regions (Wales, South Australia, and Victoria), and cities (Calgary, London, Cardiff, Santa Monica, and the Hague) have accepted the Ecological Footprint as a measure of their own sustainability, and have prepared plans and strategies for reducing it. The United Nations, in the document "State of the World Population 2001", calculated the Ecological Footprint. The European Parliament has printed a document for governments, which should serve as a tool for calculating the Ecological Footprint. Since 2002 we have been able to calculate our own Ecological Footprint on the internet. Among the non-governmental organizations, the World Wildlife Fund (WWF) uses the Ecological Footprint Analysis to promote conservation and sustainability. Using the Ecological Footprint Analysis, this organization has developed a program, "One Planet Living", in order to deal with the global environmental deficit by 2050. (Hadley, 2006)

4.1.3 The Concept of the Ecological Footprint

The Ecological Footprint takes root from the fact that all renewable resources come from the Earth. Non-renewable resources are not accessed, as by definition their use is not sustainable.

Here are some background points for understanding the Ecological Footprint concept:

1) The Earth is a closed system, which is to say that everything we consume comes from the Earth and goes back to the Earth;
2) The Earth is finite in size, which is to say that there are limits in terms of what the Earth can produce (i.e., the Earth's productive capacity), and how much waste the Earth can absorb; and
3) The Earth's production capacity and waste-absorption capacity can be measured, as can human consumption and waste production.

Taking these three points together, it is possible to express an individual human being's (or the entire human population's) consumption and waste production on an area basis—i.e., to calculate the bio-productive area of the Earth necessary to support humans at a given level of consumption and waste production. Of the **51** billion hectares of the Earth's surface, only **12.2** billion hectares are biologically productive and, therefore, capable of providing resources and treating waste, that is to say, **11.1** billion hectares of land and **1.1** billion hectares of water. (Penn State Personal Web Space, n.d.)(p. 1)

4.1.4 General points about the Ecological Footprint

The topic of the Ecological Footprint is not new, however, it is rapidly gaining in importance. The Ecological Footprint is a measure of human demand on the Earth's eco-systems. Basically, it is the comparison between the needs of humanity, and the planet's capacity to regenerate, representing the surface of biologically-productive land and sea necessary to supply the renewable resources a human population consumes, and absorb the waste produced during that process.

Every human activity is closely linked to a certain biologically-productive area. The Ecological Footprint represents the sum of these areas, regardless of their location on the Earth.

Consumption-wise, there are six types of Ecological Footprint:

1. Built-up-land Footprint – it is calculated according to the land area covered with different types of infrastructure, like roads, residential objects, industrial objects, and artificial lakes;
2. Forest Footprint – it is calculated according to the annual consumption of firewood, and all types of wood assortments;
3. Crop land Footprint – it is calculated according to the land area used for the growing of crops and other agricultural products, for human and animal consumption, fuel production, etc.;
4. Grazing land Footprint – it refers to the surface of grazing land used for cattle breeding, necessary for the production of meat, dairy products, hide, and wool;
5. Fishing grounds Footprint – it is calculated according to the estimated primary production, necessary to compensate for fish and seafood harvesting; it is based on the fish-harvesting data for 1,436 seawater and 268 freshwater species;
6. Carbon uptake Footprint – it refers to the forest area necessary for the absorption of CO_2 emissions coming from fossil fuel combustions, through land conversion, and chemical processes, excluding the amounts absorbed by the oceans. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 9)

4.1.5 How much Earth do we have and what is Fair Earth Share?

"The Earth seems like such a large place, will we ever have too many people for the Earth to produce the things needed to survive? What about the plants and animals that live here? Is there enough for all of us? How much of the Earth is actually available to produce the food we need, and to clean up our wastes and what is Fair Earth Share?" (Institute for Sustainable Energy, n.d.)(p. 4) The answers can be found in Annex for Chapter 4.

4.1.6 Biocapacity and Ecological Footprint

With the aim of estimating whether human demands for renewable resources, together with CO_2 absorption, are sustainable, the Ecological Footprint is being compared to the Earth's regenerative capacity (biocapacity). The biocapacity of a particular surface represents its ability to renew what people demand, and it is the total regenerative capacity of the planet which is used to compensate the negative impact of the Ecological Footprint. Biocapacity is, therefore, the eco-systems' capacity to produce biological materials used by people, and to absorb waste material generated by people and CO_2. Biocapacity can vary from year to year due to climate change. Both the Ecological Footprint (as a demand for resources) and the biocapacity (as the availability of the resources) are presented in global hectares (gha), a unit of measurement indicating the production capacity of 1 ha of a surface, taking into account the average global productivity. The total Footprint for a given population's activities is measured in terms of 'global hectares.' (Population Matters.org, 2016)

4.1.7 Biocapacity and the ecological deficit (overshoot)

Performed at the global level, the most recent Footprint analysis shows that the world's human population requires 1.7 Earths to maintain the current instantaneous use of the Earth. That is, we are all overshooting the Earth's sustainable supply of resources by 40%. We might wonder, how is it possible to exceed 100%? The same way it is possible to spend 140% of our monthly income. There is a supply in the bank (just as there is on Earth). In the case of the bank account, we all know what happens if the overspending of resources stays too long above 100%. It will be no different for the Earth. (Penn State Personal Web Space, n.d.)(p.3)

Since 1961, when the Ecological Footprint started to be counted, humanity's need for natural resources and the absorption of carbon dioxide has more than doubled. In the 70s of the XX century, the needs of mankind exceeded the biocapacity of the Earth. From this period, the Earth has been in an ecological deficit, with a tendency of further growth. According to data from **2014**, the Ecological Footprint of humanity is **20.6** billion global hectares, which is **2.84** gha per person, while the biocapacity is **12.2** billion gha, or **1.68** gha per person. These data tell us that the needs of humanity are almost **40%** greater than the Earth's ability to support them. More precisely, the Earth needs **1.7** years to restore its exhausted natural resources and absorb the carbon dioxide emitted for a year, as can be seen in Figure 8, in the Annex for Chapter 4.

In addition to global hectares, the Ecological Footprint can also be expressed in the number of Planet Equivalents. The *Planet Equivalent* is the number of planets that would be needed to provide life on

Earth if everyone lived as an average citizen of the community for whom the Ecological Footprint is measured. This overview should be easy to understand since it enables us to directly see the difference between the capacity of the Earth and our demands, as can be seen in Figure 9, in the Annex for Chapter 4.

According to data provided by the **2014** Global Footprint Network, the largest share in the Global Ecological Footprint comes from the most developed countries, such as Qatar (**15.7** gha/person), Luxembourg (**12.3** gha/person), the United Arab Emirates (**9.8** gha/person), America (**8.4** gha/person), Canada (**8.0** gha/person), and Australia (**6.9** gha/person). Usually, the countries with the smallest Ecological Footprint are those which are the least developed, such as Eritrea (**0.5** gha/person), Burundi (**0.6** gha/person), Haiti (**0.7** gha/person), Bangladesh (**0.8** gha/person), and Pakistan (**0.8** gha/person), as can be seen in Table 7, in the Annex for Chapter 4.

According to the **2014** Global Footprint Network, Europe has a biocapacity of **2,244,861,951** gha, or **3.07** gha/person, which is more than the average global biocapacity (**1.68** gha/person). However, the Ecological Footprint of an average European is **4.69** gha/person, which is much more than the global **2.84** gha/person. Moldova has the smallest Ecological Footprint in Europe of **1.9** gha/person, while Luxembourg has the largest Ecological Footprint in Europe of **12.3** gha/person. There are countries in Europe that do not have an ecological deficit; on the contrary, they have a biocapacity reserve because their Ecological Footprint does not exceed the global biocapacity. Such European countries with a biocapacity reserve are shown in Table 8 and Figure 10, in the Annex for Chapter 4.

According to the "2016 Living Planet Report" of the Global Footprint Network, we would need 1.7 planets to support the annual needs of mankind. The report also says that the analysis of global biocapacity reveals that almost 50% of the world's biocapacity is within the limits of only five countries. These countries are: Brazil, China, the United States, Russia, and India, as can be seen in Table 9 and Figure 11, in the Annex for Chapter 4.

By analyzing the Ecological Footprint it is possible to measure the external pressures on ecology within the boundaries of a particular state, which are constantly increasing because of those who use the natural resources of that country, but do not live there. The analysis of data from 1961 to the present day shows that humanity, in the pursuit of a more comfortable life and greater wealth, has made an unsustainable pressure on the Earth. In a resource-limited world, rich nations have a responsibility to reduce their Ecological Footprint by finding ways of living more modestly and in line with the Earth's abilities, without disturbing the existing population's quality of life. (Lukić, 2011)(p. 6)

4.1.8 Ecological deficit

The needs of people are constantly growing. However, people are overstepping their consumption limits and living at the expense of future generations. We are consuming more than the Earth's eco-system can produce. Ecological deficit emerged in the 90s of the previous century, and continues to threaten growth. Growing pressure on the eco-systems is bringing about disintegration and variation of natural habitats, and is threatening biological diversity and the well-being of humankind. According to the principle of sustainable development, a country's economic and social development should be directed in such a way that the satisfaction of today's needs do not affect the opportunities for satisfying the needs of future generations (Ruževičius, 2010)(p. 12). The Brundtland Commission's report *Our Common Future* (1987) (Brundtland, 1987)(p. 271) highlights that the government, public organizations, and enterprises are not only able to, but must combine and direct their efforts toward solving environmental concerns, as they threaten the existence of society itself.

4.1.8.1 Types of ecological deficit

There are two types of ecological deficits: global ecological deficits and local ecological deficits. *Global ecological deficits* occur when human demand from nature exceeds the renewable regenerative capacity of the biosphere. *Local ecological deficits* occur when the local eco-system is exhausted faster than it can be regenerated. According to experts' analyses in this field, the global Ecological Footprint exceeded biocapacity in the mid-80s of the XX century, and since then the planet is in ecological deficit with a tendency for further growth. As of 1961, when the Ecological Footprint began to be measured, until today, mankind's needs for natural resources and absorption of carbon dioxide emissions have more than doubled. These data show that the needs of mankind are 50% greater than the capabilities of the Earth. Specifically, it would take 1.7 years for the Earth not only to recover the exhausted natural resources, but also to absorb the carbon dioxide emitted over a year.

4.1.8.2 Ecological overshoot demonstrated

Dividing the **12.2** billion hectares available by the global population indicates that there are, on average, **1.68** bio-productive hectares per person on the planet. The 2014 Global Footprint Network Report indicates that the actual usage comes up to **20.6** billion global hectares, or **2.84** hectares per person – more than a **40%** overshoot. The overshoot result indicates that our annual spending of natural capital is eliminating natural capital profit, as well as reducing natural capital itself. Such an overshoot is ecologically unsustainable. Time series of the global Ecological Footprint indicate that human activities have been in an overshoot position for approximately three decades, and the overshoot is increasing over time.

4.1.9 What does the Ecological Footprint measure?

The Ecological Footprint allows us to examine our use of renewable resources, and identify ways to live more sustainably. The Ecological Footprint can be measured for an individual, a business, a city, or a country. The Footprint is a balance sheet for renewable resources for a given year. One side of the sheet measures the amount of renewable resources available to us; the other side of the sheet measures the amount of renewable resources required to produce what is consumed, and to absorb our wastes. In this way, we can compare what we are using from the environment with what is available. It is possible to use more renewable resources than are available to us in the short term, but this 'ecological overshoot' leads to the destruction of our natural environment. For example, it is possible to cut down trees or harvest fish quicker than they can regrow, i.e. re-multiply. Much like a bank account, we can use more than just the interest, spending our renewable resources at an increasing rate, but this means that there will be progressively less interest in future years. Many of the products and services we consume are imported. Therefore, we are indirectly using renewable resources in other parts of the world. As a result, the Consumption Ecological Footprint includes the impact of imports, and excludes the impact of exports. We can compare our Footprint to the amount of renewable resources available per person worldwide, to gain an understanding of the sustainability of our lifestyles in the global context. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 9)

4.1.10 What is the Ecological Footprint used for?

The Ecological Footprint provides us with important information about our relationship with the environment. However, it only addresses one aspect of that relationship. Hence, the Footprint must be used alongside tools that measure the preservation of habitats and species, sustainable freshwater use, and the effective management of hazardous substances. Through Ecological Footprint Accounting – of an individual, a city, a business, or humanity in general – we measure the pressure on our planet, while laying the foundations to take more serious personal and collective steps toward a more reasonable utilization of the existing resources.

During the 1970s of the previous century, the world population had already crossed the line where the annual Ecological Footprint was equal to the annual biocapacity of the planet, meaning that at the time, the speed of the consumption of the renewable resources had already reached a higher rate than that necessary for the eco-systems to regenerate, and absorb the CO_2 emissions. This phenomenon is known as *ecological overshoot*, and it has been present ever since.

The Ecological Footprint is most useful as a tool for communication about environmental sustainability. It helps to simplify the concept, and it is a starting point in providing a practical direction for a lifestyle change. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 10)

4.1.11 Different levels of Ecological Footprint

4.1.11.1 Personal calculator

The process of measuring our own Ecological Footprint helps us to better understand how our everyday choices and activities contribute to our ecological impact. It also helps us to identify what activities have the biggest impact on the environment, and inspires us to take personal and collective actions to reduce our impact and live within the means of one planet. The calculator asks a series of simple questions and then calculates the area of land required to support our lifestyle. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 10)

4.1.11.2 Footprint for business

Businesses that look ahead and actively manage their ecological risks and opportunities can gain a strong competitive advantage. The Ecological Footprint is being used to help corporations improve their market planning, set strategic direction, manage performance, and communicate their strengths.

By providing a common unit, the Footprint helps business to establish benchmarks, set quantitative targets, and evaluate alternatives for future activities. The Footprint is compatible with all scales of company operations, and provides both total and detailed results.

Ecological Footprint analysis reveals where regions, industrial sectors, and companies will face increasing limits in resources, such as energy, forest, croplands, pastures, and fisheries. It also helps identify strategies that will succeed in a resource-restricted world, including products and services that will be most needed in the future. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 10)

4.1.11.3 Footprint for cities

Local governments succeed by helping all their inhabitants live fulfilling lives, both today and in the future. The availability of natural capital, nature's ability to renew and provide resources and services, is not the only ingredient in this vision. However, without natural capital – healthy food, energy for transport and heat, fiber for paper, clothing and shelter, fresh air and clean water – such a vision is impossible. Thus, providing current and future human well-being depends on protecting natural capital from systematic overuse; otherwise, nature will no longer be able to secure society with these basic services. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 10)

4.1.11.4 What's in it for local governments?

Ecological Footprint accounts allow governments to track a city or region's demand on natural capital, and to compare this demand with the amount of natural capital actually available. The accounts also give governments the ability to answer more specific questions about the distribution of these demands within their economy. In other words, it gives them information about their resource absorption.

For example, Footprint accounts reveal the ecological demand associated with residential consumption, the production of value-added products, and the generation of exports. They also help assess the ecological capacity included in the imports upon which a region depends. This can explain the region's restrictions or future obligations in comparison with other regions of the world, and identify opportunities to defend or improve the local life quality. Footprint accounts help governments become more specific about sustainability in a number of ways. The accounts provide a common language and a clearly defined methodology that can be used to support staff training and to communicate about sustainability issues with other levels of government or with the public.

Footprint accounts add value to existing data sets on production, trade and environmental performance by providing a comprehensive way to interpret them. For instance, the accounts can help guide "environmental management systems" by offering a framework for gathering and organizing data, setting targets and tracking progress. The accounts can also serve as environmental reporting requirements, and inform strategic decision-making for regional economic development.

The global effort for sustainability will be won, or lost, in the world's cities, where urban design may influence over 70% of people's Ecological Footprint. High-Footprint cities can reduce this demand on nature greatly with existing technology. Many of these savings also cut costs and make cities more livable. Since urban infrastructure is long-lasting and influences resource needs for decades to come, infrastructure decisions can make or break a city's future. Which cities are building future resource traps? Which ones are building opportunities for resource-efficient and more competitive lifestyles?

Without regional resource accounting, governments can easily overlook or fail to realize the extent of these kinds of opportunities and threats. The Ecological Footprint, a comprehensive, science-based resource accounting system that compares people's use of nature with nature's ability to regenerate, helps eliminate this blind spot. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 10)

4.1.11.5 Footprint for nations

In today's world, where humanity is already exceeding planetary limits, ecological resources are becoming more critical. Each country has its own ecological risk profile – many are running ecological deficits, with Footprints larger than their own biological capacity. Others depend heavily on resources from elsewhere, which are under increasing pressure.

In some areas of the world, the implications of ecological deficits can be devastating, leading to resource loss, eco-system collapse, debt, poverty, famine, and war.

The Ecological Footprint is a resource accounting tool that helps countries understand their ecological balance sheet, and gives them the data necessary to manage their resources and secure their future.

National governments using the Footprint are able to:

1. Assess the value of their country's ecological resources;
2. Monitor and manage their resources;
3. Identify the risks associated with ecological deficits;
4. Set policy based on ecological reality and make safeguarding resources a top priority; and
5. Measure progress toward their goals.

It is almost certainly the case that countries and regions with surplus ecological reserves — not the ones relying on continued ecological deficit spending — will emerge as the powerful and sustainable economies and societies of the future. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 11)

The Ecological Footprint looks at the total amount of global hectares that are required to support a particular population, regardless of whether those hectares are within the national borders where that population lives. It does this by considering the net consumption of the population (or activity) of interest, subtracting the global hectares used for exports from those used for imports and production. The Footprints of individual nations vary considerably, from exceeding **9** gha per capita for such countries as Qatar (**15.7 gha**), Luxembourg (**12.3 gha**), and the United Arab Emirates (**9.8 gha**), to lows less than **0.7 gha** per capita for such countries as Eritrea (**0.5 gha**), Timor (**0.6 gha**), and Haiti (**0.7 gha**) (Global Footprint Network, 2014).

By comparing the Footprint measure with the actual bio-productive capacity of individual nations it is possible to determine if that country is in an ecological deficit (using more than it has) or has an ecological reserve. Kuwait (**-7.0 gha**), the United Arab Emirates (**-9.2 gha**), and Belgium (**-5.8 gha**) are all in an ecological deficit, using more global hectares than their own land mass provides. Countries with an ecological reserve include Gabon (**+23.0**), Bolivia (**+13.4**), and Mongolia (**+5.5**) (Global Footprint Network, 2018).

Some countries, but not all, can run ecological deficits by taking over bio-productive hectares from other countries. However, the global deficit represented by the **40%** overshoot cannot be compensated for as there is only one planet available. These data highlight the close connection between ecological sustainability and just distribution, and the contribution of international trade to unfairness in national Footprints.

4.1.11.6 Ecological Footprint per capita

Ecological Footprint Per Capita is a tool of comparison between human consumption and lifestyle, and nature’s capacity to sustain it. This tool may provide the decision-makers with relevant information on whether a population of a state consumes more or less of the resources available on its territory, as well as on the possibilities of leading such a lifestyle in other parts of the world. Additionally, it can serve as a useful means of education, teaching people about the Earth’s limited capacity, and human overconsumption, with the aim of changing the individual lifestyle, arguing that many contemporary lifestyles are not sustainable. Besides measuring the individual lifestyle, the Ecological Footprint is used for the calculation of the sustainability of products and services, organizations, industrial sectors, parts of towns and settlements, cities, regions, and states/nations. Since 2006, a set of standards has been established in this field, elaborating in detail on communication processes and calculating procedures. These standards have been developed within a public process, headed by the Global Footprint Network organization, and are available on: www.footprintstandards.org. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 11)

4.1.12 Ecological Footprint and the Human Development Index

The authors of the Ecological Footprint indicate that this indicator does not take into consideration one's life well-being, therefore, it does not include the qualitative aspects of our society. The Human Development Index (HDI) is an indicator that measures the human life quality and provides the basis for predicting the opportunities that each individual society can have. The HDI is a statistical tool used to measure a country’s all-inclusive achievement in its social and economic dimensions. It is a composite index consisting of three indicators: a) a health indicator; b) an education indicator; and, c) a standard of living indicator. The HDI is an indicator that combines results from three areas, which measure the life quality in a society:

1. The possibility of a long and healthy life (measured by the average lifespan);
2. The possibility of education (two thirds of the educational indicator measures adults' literacy and one third measures the number of students enrolled at a primary, secondary and tertiary level);
3. The possibility of decent living conditions (GDP per capita).

A country scores higher on the HDI when the lifespan is higher, the education level is higher, and the GDP per capita is higher.

It can be said that the Human Development Index is an indicator that can be added to the Ecological Footprint. In this context, four possible scenarios are mentioned (Machingura & Lally, 2017)(p. 40):

1. The country has met the life quality, but at the expense of excessive exploitation of one's own and others' natural resources (an example of wealthy economically-developed countries);
2. The country has not met a certain level of life quality; however, it has preserved natural resources (characteristic of certain countries of South America);
3. The country has neither met a certain level of life quality, nor has it preserved natural resources (the countries of Africa); and
4. The country has met a certain level of life quality and has preserved natural resources (in anticipation of the model).

The HDI represents the sum of the above-mentioned indicators, which means that the Human Development Index attempts to rank all the countries of the world on a scale of 0 (lowest human development) to 1 (highest human development) based on three development outcomes: long life, measured by the life expectancy at birth; knowledge, measured by the evaluated average adult literacy and average age; and, living standard, measured by the real "per capita" income adjusted by the different parity (equivalence) of the purchasing power of each country's currency, which reflects the cost of living and the assumption of marginal revenue reduction.

The Human Development Index is an indicator that ranks countries according to the level of human development, classifying them into the following categories: developed countries, developing countries, and underdeveloped countries. The Index tries to show human progress through a connection between income and well-being. In the 2010 Human Development Report, the UNDP began using the HDI calculation, which is a concise measure of human development.

The HDI ranks all countries into three groups: low human development (0.0 to 0.499), middle human development (0.50 to 0.799), and high human development (0.80 to 1.0).

The following Figure 15, in the Annex for Chapter 4, represents the comparison of the Ecological Footprint and Human Development Index as an indicator of sustainability. By comparing these two indicators, we get a clear picture of whether a particular society has managed to harmonize acceptable consumption of resources and energy with a high level of life quality, and, on that basis, it can be assessed as sustainable or unsustainable.

The graph exemplifies the challenge of creating a high level of human well-being without depleting the planet's or a region's ecological resource base. As can be seen, the lower right quadrant represents the goal of sustainable development, i.e., high human development, within levels of resource consumption that can be extended globally. Only very few nations have managed to enter this quadrant.

Fortunately, there are many opportunities to manage and use biocapacity more effectively and to invest in those human development programs that move countries and their people closer to the lower right quadrant, that is, to global long-term sustainability.

4.1.13 The biggest and the smallest worldwide Ecological Footprints in 2014

Until the middle of the XX century there were no countries as ecological borrowers, most of the countries had a plentiful capacity of the land and biocapacity. The most threatening fact is that the number of ecological borrower countries is continuously growing at an increasing pace. The international organization "World Footprint Network" has proved that there is a direct dependence between the Ecological Footprint and the development level of the country (Living, 2018) (wwf.panda.org, 2018). This means that developed countries have bigger Ecological Footprints, and their damaging power to the environment is more serious. Third world countries have the smallest Ecological Footprint. Often, these countries have a great deal of land biocapacity, as well as a comparatively low density of population, which helps in protecting nature. Also, the citizens of undeveloped countries have lower demands when compared to, for instance, an average American; satisfying minimal basic needs is sufficient for the citizens of these countries.

In the Annex for Chapter 4, Figure 13 (see page A14), and Tables 10 (see page A12), 11 (see page A13) and 12 (see page A14) present the worldwide standard for comparing biocapacity with the Ecological Footprint in order to establish an ecological deficit or reserve. It should be noted that the present level of human consumption already exceeds the Earth's ecological potential, i.e., the Ecological Footprint of all the countries in the world exceeds nature's capacity for regeneration. In 2014, the Ecological Footprint of the complete population of the world was **20.6** billion gha (on average **2.84** gha per person), while the Earth's total productive land and marine area (or biological potential) was only **12.2** billion gha (**1.68** gha per person). In other words, according to the current rate of global consumption, humanity needs **1.7** planet Earths.

The greatest Ecological Footprint per capita is on the continents of North America, Australia, and Europe. As seen from Table 7, the greatest Ecological Footprint is in Qatar (**15.7** gha per capita), Luxembourg (**12.3**), the United Arab Emirates (**9.8**), Kuwait (**7.6**), the USA (**8.4**), Belgium (**6.7**), and the Netherlands (**5.9**). Finland and Sweden have the biggest ecological reserve, and Belgium and the Netherlands have the biggest ecological deficit among the EU countries. It should be noted that, so far, Latvia and Estonia have a positive ecological balance; meanwhile, the Ecological Footprint of the United Kingdom, Germany, and North Macedonia exceeds the countries' biological potential respectively by **3.6**, **3.3**, and **1.5** gha. The biggest ecological reserves in the world are in French Guiana (**100.3** gha per capita), Suriname (**84.6**), Guyana (**65.9**), Gabon (**23**), Bolivia (**13.4**), Canada (**7.2**), and Australia (**6.4**).

Nearly **7** % of the world's population lives on the territory of the European Union, yet they use **20 %** of the world's natural resources. The Ecological Footprint of EU citizens exceeds the biological eco-system potential **2.1** times. From 1961 until 2014, the Ecological Footprint of the EU grew by **80 %** (Global Footprint Network, 2014). If people all over the world followed the same model of consumption as the US citizens, we would need **5** planet Earths, and if everyone consumed the same as the citizens of the developed EU countries, at least **2.8** planet Earths would be needed.

The negative ecological balance of China (**2.7** gha per capita) is especially troubling, since the number of citizens in this country reached **one billion** people, which makes up for about **19.5%** of the total world's population. The global Ecological Footprint from the 60s of the previous century has increased by **60%**. The degradation of our planet is helped by globalization processes, as well as by an unendingly growing scope of international trading. Furthermore, the developed countries are encouraged by growing international trade to “move” their Ecological Footprint to other regions of the world, often without considering the ecological, social, and economic consequences to the origin country of imported products, as well as the sustainable development of the complete world. This case demands the question and calculations of how much energy, other natural resources, or dangerous chemical substances had been used in the production of a certain product, how this influenced the environment and the health of the citizens in the area of production, and how this influenced the ecological balance of the entire planet. The considerable damage to the global eco-system done by additional resources used for transportation of the products should also be calculated and valued.

If there are no serious environmental and sustainable development measures applied in the near future on a global scale, then by 2040 the maintenance of the present, irresponsible levels of consumption and lifestyles will demand two planet Earths (WWF, Annual review, 2018 (wwf.panda.org, 2018)). This is why both the EU and all other economically-developed countries throughout the world have prepared a new sustainable development strategy that involves both the significant development of the production of renewable natural resources, and the implementation of various environmental measures. Sustainable development can encourage the wider application of sustainable trade and fair trade principles and standards on a worldwide scale. The agreement with these standards is validated by a suitable certification and labelling system which covers the use of natural resources and energy, the formation of hazardous waste, and social responsibility and justice.

Nature can renew its resources, however, only at a certain pace. People are constantly consuming more renewable resources than nature is able to regenerate. The main global aim is to unite humanity to save the planet. As long as the representatives of the governments and corporations are unfamiliar with the level of natural resources used, and how these resources match with the present stock of resources, the over-usage may remain unnoticed, which will cause the ecological deficit to grow, and the opportunities to satisfy social needs will decrease.

It can be seen from Table 12, in the Annex for Chapter 4, that all Balkan countries are in an ecological deficit.

Figure 14, in the Annex for Chapter 4, presents two possible scenarios of our planet’s ecological development. The first (worst-case scenario) states that without global radical measures to decrease the Ecological Footprint, the present consumption level in the period 2040 - 2050 will require twice as many resources than there are on planet Earth (see line I, Figure 14, in the Annex for Chapter 4).

Therefore, we will be living at the expense of future generations, and, inevitably, ecological, economic and social degradation consequences will be reached. The second (best-case scenario) predicts that global environmental agreements, the development of environment-preserving management systems and tools, environmental education of society, and individual efforts to decrease one's personal Ecological Footprint can redirect the development of planet Earth toward a sustainable ecological health development (see Figure 14, line II in the Annex for Chapter 4).

Environmental degradation of our planet and Ecological Footprint indicators can be reduced by the implementation of various governmental and public administration measures. That can be illustrated with the example from EU environmental policies. The General Union Environment Action Program to 2020 (European Parliament, 2013) has introduced the concept of integrated product policy that promotes strategies oriented to the integration of environmental policy in the realization of an increasing improvement of environmental performance of products during their life cycle, and the development of a green market through the cooperation among public authorities, participants, and consumers. The involvement of the public administration in "green" choices is a simple and effective way of increasing green demand, and, consequently, of creating market openings for the selling of green products. So, for example, the government institutions responsible for formulating North Macedonia's environmental policies can improve the environmental certification infrastructure, carry out realistic development of "green purchases", encourage organizations of the country to create and certify EMAS (Eco-Management and Audit Scheme) environmental management systems, and involve schools in the globally acknowledged and effective Kids' ISO 14000 program (International Organization for Standardization, 2003). The implementation of such a program in our country is very important and should be funded by the government as well as by organizations declaring their social responsibility status. The environmental education of children is one of the most important measures for dealing with environmental problems in our country, and in the world, and helps to achieve an ecological balance. Effective environmental awareness should also involve tertiary students from all disciplines, business enterprises, as well as the public sector and government administration institutions.

Ecological Footprint indicators can be reduced with the development of such tax implementation: environmental management systems (ISO 14001 and EMAS), environmental certification and labelling of products, environmental certification of accommodation and recreation services, FSC (Forest Stewardship Council) or PEFC (Program for the Endorsement of Forest Certification Council) certification of forests and the timber supply chain, energy certification of buildings, ecological and ergonomic TCO (Total Cost of Ownership) certification of computer equipment, mobile phones, and office furniture, ecological certification of automobiles, mandatory labelling of efficiency and other characteristics of household appliances, etc.

4.1.14 Limitations

The Ecological Footprint is not a precise measure of ecological sustainability. While it is perhaps the best estimate to date, it is important to accept its limitations. In general, the Footprint minimizes the impact of human activities on the biosphere. Any applications of the Footprint methodology must keep this aspect in mind. Because it focuses on renewable resources, the Footprint provides limited information about most non-renewable resources and their impact on eco-systems (with the exception of fossil fuel impacts, which it partially addresses).

The concept of "global hectares" of world average bio-productivity is useful for looking at issues related to the global Footprint. However, individual applications refer to specific locations where there is an impact. These local areas may have bio-productivity measures that differ from the global average; where available, local data can be used. Another limitation is that the approach allows only general types of bio-productive areas to be identified (e.g. cropland, forests, etc.); specific eco-systems within these areas are not dealt with. These limitations do not discredit the Footprint, but rather highlight the importance of interpreting any specific application with these limitations in mind.

The Ecological Footprint shows the effect that the inhabitants of a particular region or country have on the environment where they live, and on the natural resources. The Ecological Footprint, is, in fact, only an environmental protection indicator. It does not integrate social and economic indicators, which are important while estimating the sustainable development of the country, region or city. In Ruževičius's opinion, this is the main flaw of this index. Because of that, the Ecological Footprint can be considered to be an integral indicator of sustainable development only partially. (Ruževičius, 2010)

4.1.15 Future directions

Efforts are underway to standardize and refine the methodology underlying the Footprint, and to incorporate areas or issues not currently represented. This continuous attention to methodological and conceptual precision is a positive move and promises to increase the usefulness of this sustainability indicator. The instinctive attraction of the Footprint is another advantage, leading to its acceptance in many projects.

4.2 Energy Footprint

4.2.1 What is an Energy Footprint?

Energy generation and consumption impose a great impact on the environment due to CO_2 emissions. If those energy-related emissions of CO_2 from fossil fuel combustion and electricity generation indicate the forest land area necessary to absorb (sequestrate) those emissions, then that indicator is known as an *Energy Footprint,* and is measured in global hectares. If the same emissions of CO_2 are expressed in mass units, then that indicator is known as a *Carbon Footprint,* and is measured in kilograms or tons.

The Energy Footprint is **58%** of humanity's overall Ecological Footprint, and it is the most rapidly-growing component. Humanity's Energy Footprint has increased by **57.5%**; from 0.99 gha in 1961 to **1.7 gha** in 2014. Reducing humanity's Energy Footprint is the most essential step we can take to end overshoot, and live within the means of our planet.

Nowadays, the term *Carbon Footprint* frequently refers to the amount of carbon (usually in tons) which is emitted by an activity or organization. The Energy Footprint as a carbon component of the Ecological Footprint takes a slightly different approach, converting the amount of carbon dioxide into the amount of productive land and sea area required to absorb carbon dioxide emissions. This tells us the demand on the planet that results from burning fossil fuels.

4.2.2 Energy Footprint components and units

The Energy Footprint can be classified into concrete components such as the Fossil Fuel Footprint, the Hydro-electricity Footprint, and the Nuclear Footprint, all of which are expressed as the area of forest that is necessary to compensate for human-induced CO_2. The unit of measurement can be gha or local hectares, with a specific carbon sequestration estimate.

The Energy Footprint as an indicator can be involved in:

a) Sustainable Development Analysis (as a component of Ecological Footprint), and
b) Energy Management, or more precisely Energy Efficiency Analysis (where the Energy Footprint is the main culprit of harmful gases emissions and air pollution).

In our thesis we will restrict the discussion of the Energy Footprint only in the environmental domain of sustainability and energy management.

Jasch (2000) (Jasch, 2000) describes energy indicators as being crucial to sustainable development and energy management-related targets. Concerning nature, as well as the quality of energy indicators, differences exist across industries, as well as across countries. Overall, we will try to provide evidence concerning the role of the Energy Footprint both as an indicator of sustainable development and energy management.

4.2.3 Energy Footprint as an indicator of sustainability

The concept of *Footprint* originates from the idea of the Ecological Footprint, which was formally introduced to the scientific community in the 1990s of the previous century. Since then, many different Footprint-style indicators have been created and have become complementary to the Ecological Footprint, including the Energy Footprint, the Water Footprint, the Energy Footprint, the Exergy Footprint, the Carbon Footprint, the Biodiversity Footprint, the Chemical Footprint, the Phosphorus Footprint, the Nitrogen Footprint, and so on. (Fang, et al., 2014)(p. 2)

With no exception, none of the Footprints are able to represent the full human impact on the Earth. This requires the development of a combination of the existing Footprints in order to be more informative in terms of representing human-imposed environmental pressure in multi-dimensions. (Fang, et al., 2013)(p. 2)

The Footprints are built on different conceptual origins, and are restricted in application scopes. Despite sharing the term Footprint, the Energy Footprint was previously a subset of the Ecological Footprint, while the root of the Carbon Footprint traces back to GWP (Global Warming Potential). In many cases, the Ecological Footprint is applied to a region or country level, while the Carbon Footprint is usually restricted to a product or process level.

Each Footprint covers limited scopes of human activities. Specifically, the Ecological Footprint (excluding the Energy Footprint) focuses on the biological resources consumption, the Energy Footprint focuses on the energy-related CO_2 emissions, and the Carbon Footprint mainly focuses on the life cycle GHGs emissions for products manufactured. It is reasonable that partial overlapping exists among Footprints that are not completely mutually exclusive. (Fang, et al., 2013)(p. 6)

4.2.3.1 Increasing the Energy Footprint

In many regions, environmental problems that are both local (high rates of urbanization, industrial activities, land use changes, or agricultural practices), and global (desertification or deforestation) have considerably increased the Energy Footprint, since they have reduced the ability of land to absorb CO_2. Increasing plant growth (for sequestration) is one of the key ways in which the Energy Footprint can be reduced, besides the use of renewable energy sources such as solar and wind energy.

On the other hand, even though wind energy development is being promoted as a "clean" alternative, still, this perspective often fails to note the increasing negative impacts of energy development on the landscape. Like oil and gas, wind energy requires a network of roads, transmission lines, and associated infrastructure to capture and transport power. (Jones, et al., 2015)

4.2.3.2 The Energy Footprint to monitor the stock depletion

The environmental implications of energy use not only affect the atmosphere where anthropogenic warming impacts have been sufficiently noted (Hertwich & Peters, 2009), but they also affect the lithosphere where fossil fuel is an essential natural resource for humanity and contributes most to the stocks of natural capital maintained throughout the world. Unlike the renewable natural resources such as cropland or grassland, the consumption of fossil energy will undoubtedly result in a diminished stock of natural capital. From a strong sustainability perspective, all renewable flows of resources and eco-system services should be carefully consumed, but finite stocks should remain constant (Niccolucci, et al., 2009). If stock depletion continues to grow a critical point beyond which a tremendously huge accumulation of debt will never be paid back by natural capital flows, the Earth-system will ultimately collapse with disastrous consequences for human beings (Wackernagel & Rees, 1997). Given this concern, it is desirable to find a way of reshaping the Energy Footprint to monitor the depletion of stocks associated with energy consumption within a given year. We argue that the Footprint family will benefit from such a remodeling because it allows for simultaneous tracking of human pressures on three life-supporting compartments of the Earth: the biosphere, the lithosphere, and the atmosphere. (Fang, et al., 2014)(p. 8)

When we look at carbon in isolation, the problem appears as a 'tragedy of the commons' (we pollute our collective atmosphere in order to advance our individual/national wealth.) But the picture changes when we see the carbon problem as part of an overall resource crisis – a symptom of human pressure on resources reaching a critical climax point. The concentration of carbon in our atmosphere is the most prominent resource issue we face. (Ambasadori održivog razvoja i životne sredine, 2013)(p. 12)

Any energy we consume, big or small, contributes to the world's carbon emissions. In order to begin reducing the amount of pollution we produce as a result of excessive consumption, we need to learn about what actions cause more carbon emissions, and what can significantly reduce them.

4.2.4 Energy Footprint as an indicator of energy management

This part provides an overview of an applied indicator predominantly on energy conservation, consumption, efficiency, and audit.

4.2.4.1 Improving the Energy Footprint by 'smart' household services technology

One approach to the conservation of household energy can be implemented through the use of intelligent household services systems. 'Smart' and integrated regulation of lighting, sun protection, ventilation, and climate control equipment - as well as other technical systems - in individual rooms and in buildings as a whole, can save a great deal of energy and reduce CO_2 emissions. Moreover, because of their size, their situation and the different individual ways in which they are used, the greatest potential improvements in energy efficiency lie in non-residential buildings such as offices, schools and industrial premises, hospitals, shopping centers, conference centers, hotels and banks.

If 'smart' household services technology is combined with the use of renewable energies, then the Energy Footprint is further improved. Renewable energy from the wind, sun, water, and the heat from the Earth are sustainable resources and available for the long term. A photovoltaic (PV) installation, for instance, offers an excellent opportunity for creating electrical power from the sun's energy. In order to be able to use the solar electricity flexibly, the PV system needs to be linked to a storage facility of some kind. In that way, home-produced energy can be made available at times of peak demand. However, the user gets optimum advantage from the energy produced only if the PV system is integrated into the household's automation system.

The energy that is supplied to a household can be divided into thermal energy, for heating, warm water and cooling, and electrical energy, for lighting and electrical and electronic appliances. A well-adjusted household automation system ensures that the appropriate amount of heat, cooling, ventilation and lighting is provided in each case, depending on the need at any given time.

Savings in the consumption of heating energy can be achieved through regulatory mechanisms in individual rooms. Sensors monitor the presence of a person in the room, as well as the temperature in the room and/or outside. The temperature is then adjusted accordingly, depending on the values returned for these various influences.

Significant savings in electricity can also be achieved by modernizing the technology of the lighting equipment. In this case, a change to LED or energy-saving lamps, the installation of sensors for lighting levels, or control via the 'human presence' sender ensure that savings are made.

Regulatory mechanisms for individual rooms and lighting management systems are just two examples of the ways in which automation can improve the energy efficiency of buildings. Industry already provides the necessary technologies for this at present. (Messe Frankfurt, 2019)

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions.

Globally we need to save energy in order to:

- Reduce the damage that we are doing to the Earth. As a human race we would probably find things rather difficult without the Earth, so it makes good sense to try to make it last.
- Reduce our dependence on the fossil fuels that are becoming increasingly limited in supply. (Ruteh, 2011)
- Reduce climate change. There is a broad-based consensus around the globe that renewable energy is important to reducing climate change.

4.2.5 Energy Footprint of human development

The Energy Footprint, besides functioning as a component of the Ecological Footprint (sustainability), can also function as an indicator of the relation between global energy use and human development (energy management).

In order to give a more accurate picture of the relation between energy use and human development we should deal with the global energy requirements to support a specific level of development regardless of the country in which the energy was actually consumed. This indicator is again commonly referred to as the Energy Footprint, and it reflects the global energy inserted in the domestic final demand (private consumption, public consumption, and investment) of a country, and links with the same current research topics such as the environmental Footprints. (Arto, et al., 2014)(p. 141)

The increasing net CO_2 emission transfers via international trade from developing to developed countries in the last decades is currently a topic of intense research due to its strong implications in terms of climate policy efficiency: (Arto & Dietzenbacher, 2014); (Davis & Caldeira, 2010); (Peters, et al., 2011). Since CO_2 emissions from the burning of fossil fuels are the primary cause of global warming (65% of total GHG emissions in 2010) (Core Writing Team, et al., 2014), it seems evident that these net emission transfers are ultimately driven by an disbalance between the energy territorially-used and the Energy Footprint. (Arto, et al., 2014)(p. 148)

4.2.6 An Energy Footprint-based tax system

If our current tax systems do not penalize damage to the planet, one solution may be to charge individuals on the basis of their personal Energy Footprint. Those eating and living locally, rarely travelling on airplanes, and using recycled or multi-purpose materials would be taxed less than high-living internationals, fueling their lifestyle with imported products and jet travel. Equally, those whose job requires frequent travel and a high-Energy Footprint would pass the tax bill on to their employers, compelling companies to include ecological impact into their bottom line. An Energy Footprint-based tax system would accelerate our transition to a regenerative economy, and help us fight climate change. (Athanasiadis, 2017)

Chapter 5 – Ecological and Energy Footprint Analysis Model

Chapter Five consists of four parts, each representing a way to reduce the Ecological and Energy Footprints which are caused by satisfying consumers' basic needs: food, housing (includes use of energy), products and services, and transport.

5.1 Ways to reduce our Ecological and Energy Footprints

People often get disappointed by sustainability, saying it is too complicated to understand. Measuring our Ecological Footprint can make this issue perfectly clear by: a) identifying what activities have the biggest impact on the environment; and b) inspiring people to take personal and collective action to reduce their impact and live within the resources of the Earth.

The Ecological and Energy Footprints are well-established mechanisms for measuring and understanding the impact that human lifestyles have on the environment. There is a limit to the amount of biologically-productive land and water available for the Earth's population, and we are now exceeding it. (SEE Change Canbera, 2019) (p. 1)

According to the Global Footprint Network, we currently consume more resources per year than our planet can produce in the same timeframe. Their calculations show that it takes the planet 18 months to regenerate everything that we use in a 12-month period. In 2018, the Earth Overshoot Day was August 1 - meaning that by that date we had taken more from nature than our planet is able to renew in the whole year.

Humanity is currently using the renewable resources of **1.7** Earths to meet our annual demands for food, energy, shelter, the things we do and buy, and transport.

There are many simple things we can do to reduce our Ecological and Energy Footprints. Let us see how to reduce our Footprints in each consumption category. The same consumption categories are used in our questionnaire, which is in the Annex for Chapter 6.

People living in richer, more developed countries generally have higher Footprints than those living in less developed countries. (See Table 11 in the Annex for Chapter 4)

5.2 Reducing our Ecological and Energy Footprints from food

We should shop at our local farmer's market and look for local, in-season foods that have not travelled long distances to reach us. Organic and other forms of low-input farming that use minimal or no pesticides and fertilizers consume up to 40% less energy than high-input farming, which is energy-intensive in its manufacture. We should choose foods with less packaging to reduce waste.

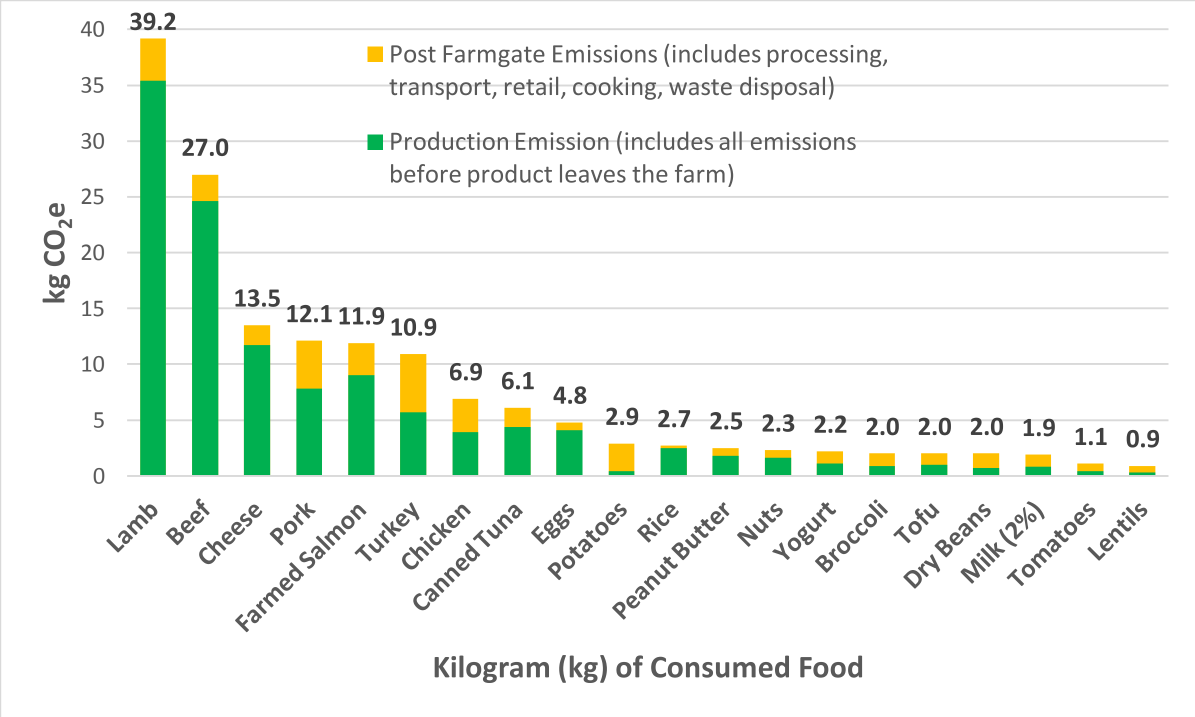

Figure 3 - Carbon emissions from consumed food (Source: https://amp.businessinsider.com/images/56000d139dd7cc24008bbbc7-640-677.png)

We can even plant a garden; growing our own fruit and vegetables reduces all the energy and waste which normally goes into getting food from the field to our plates, such as: transport, refrigeration, and packaging. In our garden we can compost food waste, as well; garbage that is not contaminated with harmful waste can be more easily recycled and sorted.

Going meatless for just one meal a week can make a difference - more often is even better. The livestock industry contributes to more greenhouse gas emissions globally than the transport sector, and the Ecological Footprint of vegetarians is estimated to be around half of that of meat consumers. (Ecogoldprint, 2017)

- *Eat locally-produced and organic food* – It has been estimated that 13% of US greenhouse gas emissions result from the production and transport of food. Transporting food requires petroleum-based fuels, and many fertilizers are also fossil fuel-based.
  The CO_2 impact of goods and services is often strikingly different from what we would expect. Bananas, for example, are fine because they are shipped by sea, but organic asparagus flown in from Peru is much more of a problem.
- *Eat less meat* – It is the second most important lifestyle change, with particular emphasis on meals containing beef and lamb. Cows and sheep emit large quantities of methane, a powerful global warming gas. A vegan diet might make as much as a 20% difference to our overall carbon impact, but simply cutting out beef will deliver a significant benefit on its own.

- *Reduce beef and dairy* – It takes a lot of resources to raise cows, and it is especially bad if we buy beef from somewhere like Brazil, where cows were grazed on land that used to be tropical forest but was cleared for agricultural use. Deforestation is a top contributor to carbon emissions and, thus, climate change. (COTAP.org - Carbon Offsets To Alleviate Poverty, n.d.)

5.3 Reducing our Ecological and Energy Footprints from housing

Housing covers an object that includes the use of energy.

5.3.1 Energy efficiency

Energy efficiency simply means using the least possible energy to get a job done, be that heating our home or office, or powering electrical items. Better energy efficiency may well be the most rapid way to reduce CO_2 emissions – and it will also save us money.

5.3.1.1 Home heating

We should:

- Focus mainly on reducing water heating and space heating/cooling (low-flow shower and faucet heads, energy star heater, regular equipment maintenance, sealing air leaks);
- Minimize use of fireplaces or wood stoves;
- Get an energy audit;
- Insulate and seal our home - reduce drafts and air leaks with caulk, insulation, and weather stripping. Many governments offer programs and incentives to facilitate this. (Global Stewards, 2019)

Poorly insulated housing requires large quantities of energy to heat. If we have properly insulated the loft and filled the cavity wall, the most important thing we can do is to draft-proof the house, something we can do ourselves. Those with solid brick or stone walls will also benefit from adding insulation, but the financial benefits are unlikely to cover the cost of doing the work, over time.

Old boilers can be hugely wasteful. Even if our current boiler is working well, it is worth thinking about a replacement if it is more than 15 years old. Our use may fall by a third or more, repaying the cost in lower bills.

Home appliances - frequent use of a clothes dryer will add to our energy bill to an extent that may surprise us. But when buying a new appliance, we should not assume to benefit financially from buying the one with the lowest level of energy consumption. There is often a surprising premium to very efficient refrigerators or washing machines. Furthermore, we can wash clothes in cold water and hang them to dry. We should make energy efficiency a primary consideration when choosing a new furnace, air conditioning unit, dishwasher, or refrigerator. Products bearing the ENERGY STAR label are recognized for having superior efficiency.

Lighting - lighting accounts for up to 15% of the electricity bill. We should turn off lights we are not using, and when we leave the room. We should replace incandescent light bulbs with compact fluorescent or LED ones. Within the last couple of years, LEDs (light-emitting diodes) have become cheap and effective. They last at least 10 years, meaning that we avoid the problem of buying new halogen bulbs every few months. Not only will our CO_2 Footprint fall, but because LEDs are so efficient, we will also help reduce the need for national grids to turn on the most expensive and polluting power stations at peak demand times on winter evenings. (Whalen, 2017)

We can reduce the amount of energy to light our home and office by:

- *Making light work for us* - clever use of reflectors and directional lamps to get the light where we need it can save another 50% in energy costs and improve the overall lighting of our home or office.
- *Switching lights off* - like all electrical items, we should switch off the lights when they are not in use. (WWF, 2019)

Thermostat – we should not set it too high or too low. Also, we should install a programmable model to turn off the heat/air conditioning when we are not home.

Solar power – we can add solar panels to the roof of our home. This costs a little more, but many providers offer financing options which minimize costs in advance. We can eliminate our electricity bill or even *earn* money by selling electricity back to the grid (unfortunately, there is still no regulation for this possibility in RNM). We all need to make better choices in what we consume, and how we produce and use energy. (Global Stewards, 2019)

5.3.1.2 Pull the plug

One very simple thing we can do is to turn off TVs, computers, and other electronics when they are not in use.

TVs, DVD players, stereos, and computers still use 10-60% of power even when on 'stand by' mode. And some appliances, like digital set top boxes, cost nearly as much to run on stand-by mode as they do when they are switched on.

- We should use a power strip for our home cinema and office equipment to easily turn multiple devices on and off at the wall, all at once.

- We should turn off our computer at night – at home and at work.
- We should unplug chargers for mobile phones and other mobile devices when we are not using them. (WWF, 2019)

5.3.1.3 Only use what is really needed

Most of us, especially in the developed world, take energy for granted – so we do not tend to take much notice of what we might be using unnecessarily.

Besides switching off lights and electrical appliances when they are not in use, we can also save energy by:

- *Turning the heating down in winter* - Do we really need to be walking around in a T-shirt all year round? We could set the temperature on our heating system a little lower to save energy. Sometimes putting on an extra sweater is more effective, and it saves us money on heating bills. Turning down the thermostat by just 1°C in winter can save up to 10% per year on heating bills.
- *Turning the cooling up in summer* - We could set our air conditioner a little higher in summer.
- *Using water wisely* - Public water systems require a lot of energy to purify and distribute water to households – so saving water can lower greenhouse gas emissions. We should also make sure the water thermostat is not set above 60°C (140°F), and take a short shower instead of a bath to minimize the amount of energy we use to heat water.
- *Loving laptops* - We could get a laptop instead of a desktop – it consumes five times less electricity. We could enable the power management function on our computer - contrary to popular belief, screen savers do not save energy.
- *Hanging it out to dry* - Traditional clothes dryers are energy intensive – and so-called "condensation" models (dryers without an exhaust tube) use even more energy. Drying our clothes on a clothes line, either inside or outside, uses no energy at all. If this is not an option, we should make sure the washing machine is spinning the clothes properly, reducing drying time. Drying clothes by spinning is 20 times less energy intensive than drying them with heat in a clothes dryer.
- *Washing clothes in cold water* - Energy Star has found that 90% of the energy used by running the washing machine is used to heat water. We could skip this step by washing in cold water instead, to save energy and extend the life of our clothing. If there is concern that our clothes will not be as clean, it is worth noting that several detergents are

formulated specifically to work in cold water, like Tide Coldwater. Washing clothes at 30°C rather than 40°C reduces electricity consumption by around 40%, on average.

- *Keeping the refrigerator cool* – We should keep the refrigerator at the right temperature and defrost it regularly to keep it working efficiently. We should not leave the doors open for longer than necessary, and make sure, too, that the door seals are airtight. We can test this by closing the door over a piece of paper so it is half in and half out: if we can pull the paper out easily, the hinge may need adjustment, or the seal may need replacing.
- *Bringing just enough to boil* - When using a kettle, we should only boil as much water as we need; it will save electricity and boil the water more quickly.
- *Being careful with water usage* – Using water efficiently at home, at school, and at the office helps protect freshwater resources. We could lower the amount of energy used to pump, treat, and heat water by washing our car less often, using climate-appropriate plants in our garden, installing drip irrigation so that plants receive only what they need, and making water-efficient choices when purchasing shower heads, faucet heads, toilets, dishwashers, and washing machines. (WWF, 2019)

How much perfectly good water do we flush down the drain? Using water more efficiently not only saves water, it can also lower greenhouse gas emissions, as public water systems require a lot of energy to purify and distribute water to households. Using less hot water saves further emissions, as less energy is used to heat the water. We should:

- *Turn off the tap* - We should not let the water run while shaving, brushing teeth, or washing vegetables.
- *Fix dripping taps* - A tap dripping 45 times per minute wastes around 1,000 liters of water a month, the equivalent of 10 baths per year.
- *Take short showers instead of a bath* - We should make sure, too, that the water thermostat is not set above 60°C (140°F).
- *Install water-saving, low-flow shower heads* - These deliver good performance for only half of the water use (5-7 liters per minute instead of 10-18 liters per minute; a savings of 70,000 liters over 10 years).
- *Install a flush saver on the toilet* - Two-button double flush toilets let us control how much water we use.
- *Collect and reuse* - Collect rainwater. Why waste drinking water on the lawn? We could get a water tank (butt) and use rainwater to water plants instead.

- *Collect rinsing water* - We can also reuse water from washing vegetables and rinsing lightly-soiled dishes to water garden or house plants. (LeNôtre Alumni, 2018)

We could try out easy ways to save water by:

- Running the dishwasher and the washing machine only when full, and selecting an economy program at the lowest possible temperature.
- Washing our car less often. We could take it to a carwash; usually commercial carwashes use less water per wash than we would need at home. (WWF - World Wide Fund for Nature, n.d.)

5.4 Reducing our Ecological and Energy Footprints from products and services

5.4.1 Using our consumer power

One of the greatest day-to-day positive impacts we can have is simply to be an informed and selective shopper. Our position as a consumer gives us tremendous power. If we reject food and goods produced in an unsustainable manner, and instead choose environmentally-friendly alternatives, the companies will listen – and change their practices.

5.4.2 Saving forests and wildlife by wisely choosing wood

One of the main causes of forest loss is illegal logging, which is fed by a high demand for timber and home heating. This wood, then, ends up in our shops and, ultimately, our homes. So, our garden furniture or wooden flooring may have contributed to the destruction of the world's most valuable rainforests – and the animals and other plants that live there. We can help stop this. Businesses will finally listen to their customers. If we stop buying timber that has been illegally produced, then the suppliers of this timber will have no choice but to change as well. (Garbato, 2006)(p. 1)

We should not flush forests down the toilet. Every day, about 270,000 trees are flushed down the drain, or end up as garbage all over the world. We should buy better-produced products and look for eco-labels that make a difference. (WWF, 2005)

5.4.3 Other ways to reduce our Ecological and Energy Footprints

- *Consume less.* Simply buying less stuff is a good route to lower emissions. A suit made of wool may have a carbon impact equivalent to our home’s electricity use for a month; a single T-shirt may have caused emissions equal to two or three days’ typical power consumption. Buying fewer and better things has an important role to play. We should minimize purchases of new products.

- *Buy from companies that support the switch to a low-carbon future.* An increasing number of businesses are committed to 100% renewable energy. Those of us concerned about climate change should buy from businesses acting most aggressively to reduce their climate impact.
- Large fuel companies and electricity generation businesses have been able to raise the many billions of new finance they need. Now, by contrast, money managers are increasingly careful of backing the investment plans of oil companies and switching to renewable projects. And, activist investors around the world are selling their holdings in fossil fuels, making it more difficult for these companies to raise new money. Public support for those backing out of oil, gas and coal helps keep up the pressure.
- Politicians tend to do what their electorates want. We need to actively communicate high levels of approval for renewable energy sources to our representatives and point out that fossil fuel use is far less politically popular.
- *Buy gas and electricity from retailers who sell renewable power.* This helps grow their businesses and improves their ability to provide cost-competitive fuels to us. Renewable natural gas is just coming on to the market in reasonable quantities in many countries, and fossil-free electricity is widely available. We should think about switching to a supplier that is working to provide 100% clean energy. (The Guardian, n.d.)

We should:

- *Choose furnishings that are second-hand* - or recycled, or sustainably produced.
- *Use biodegradable, non-toxic cleaning products* - for our health, and the environment.
- *Buy less* - We should try to get our things repaired, as this supports local businesses and avoids waste. We should replace items only when we really need to and try to buy quality products that will have a longer life-span.
- *Recycle all our paper, glass, aluminum, and plastic* - We should not recycle electronics; we should find the recycling options in Pakomak in our area. (Center for Sustainable Economy, 2019)
- *Skip bottled water* - Bottling water is an incredible waste of our planet's limited resources. It takes 3 liters of water to bottle just one, so use a water tap filter at home.

- *Buy a coffee tumbler* - Let's make our morning coffee eco-friendlier by purchasing a coffee tumbler.
- *Bring our own grocery bags* - We should use a reusable bag for our groceries to avoid the waste from plastic and paper bags. Plastic bags can take up to 1,000 years to decompose, and neither paper nor compostable bags are much better. Some grocery stores provide their own reusable bags, or we can buy one. We should just make sure to actually use the bag. We could try keeping it in the trunk of our car to be safe.
- *Ditch paper towels* - Do we use paper towels to clean? Why not use a cloth rag instead? We should recycle some old T-shirts, or just use some washcloths from Top Shop. We will save paper and money. If we use paper towels in the kitchen, a newspaper can be a good alternative, too.
- *Go to the library* - According to Eco-Libris, over 30 million trees are cut down annually to produce the paper that makes books to be read in the United States alone. We could go to the library instead for our books and magazines – it is free.
- *Go paperless* - How much mail do we get every day? How much of it do we actually need? We should reduce fossil fuel and paper waste by paying all our bills online, and unsubscribing to catalogs. (One Tree Planted, 2017)

5.4.3.1 Be a good guest

The money we spend while travelling helps determine the development and direction of tourism, accommodation and facilities.

- *Choose "green"* - hotels, tour operators and suppliers that support sustainable development, do not impact negatively on the environment, and provide financial support to local communities.
- *Avoid damaging recreational activities* - stay away from sports which have a significant harmful impact on the environment.
- *Watch what you buy for a souvenir* - Think twice before buying any products made from any endangered species, including animal hides (skin) and body parts, tortoise-shell, ivory, or coral - they could be illegal. (The Guardian, n.d.)

5.4.4 Reduce, Re-use, Repair and Recycle

5.4.4.1 Reduce

Reducing the number of things that need to be thrown away reduces the amount of materials which have to be extracted and mined. We should all avoid products with excessive packaging.

- The production of the packaging uses additional energy;
- The extra volume and weight will have to be transported (by trucks, aircraft, ships, etc.);
- The packaging will be thrown out and will need to be collected from our home by a large waste disposal truck;
- Packaging, then, takes up more space at landfill sites.

5.4.4.2 Re-use

We should try and re-use products for as long as possible. It is amazing how often people buy certain products and use them only once or twice, even though they can be re-used many times. For instance, can we think of some items of clothing we have worn only once?

5.4.4.3 Recycle

Throwing things away is a waste of the energy and the resources taken to make the product. Recycling uses less energy and produces less pollution than making things from scratch.

For example:

- Making aluminum cans from old ones uses 1/12 of the energy to make them from raw materials;
- For glass bottles, 315 kg of CO_2 is saved per ton of glass recycled after taking into account transportation and processing;
- Making bags from recycled polythene takes 1/3 the sulphur dioxide (SO_2) and 1/2 the nitrous oxide (N_2O) than making them from scratch.

Another form of recycling is composting household and garden waste.

Why compost?

- It helps fertilize the soil, making plants and vegetables grow better;
- It reduces the number of refuse collections needed;
- It reduces the strain on landfill sites.

What can we compost?

- Garden waste (fallen leaves, grass cuttings, etc.);
- Kitchen waste (such as raw vegetables, fruit, crushed egg shells, tea leaves, and tea bags);
- In addition, we could try shredded paper and cardboard.

Gifting items to charity is also an excellent form of recycling. Charities not only sell old clothes, but would also appreciate other household items, such as books, music CDs, videos, etc. As well as saving the planet against global warming, we are also helping others. (Carbon Footprint Ltd, 2019)

How products can have positive and negative impacts on consumers can be found in the Annex for Chapter 5.

5.5 Reduce our Ecological and Energy Footprints from transport

5.5.1 Driving

The distance we drive matters. Reducing the mileage of the average new car from 25,000 to 16,000 kilometers a year will save more than a ton of CO_2, about 15% of the average person's Footprint. If car travel is vital, we should think about renting out an electric vehicle when our existing car reaches the end of its life. A battery car will save us money on fuel, particularly if we drive tens of thousands of kilometers a year. Even though the electricity to charge our car will be partly produced in a gas or coal power station, electric vehicles are so much more efficient that total CO_2 emissions will fall. (Trudell, 2017)

However, we should bear in mind that the making of an electric car may produce more emissions than the vehicle produces in its lifetime. Rather than buying a new electric vehicle, it may be better to have our old car on the road by maintaining it properly, and using it economically. The same is true for many other useful items; the energy needed to make a new computer or phone is many times the amount used to power it over its lifetime. Apple says 80% of the Carbon Footprint of a new laptop comes from manufacturing and distribution, not use in the home. (The Guardian, n.d.)

- *Alternatives to driving* - When possible, we should walk or ride a bike in order to avoid carbon emissions completely. Carpooling and public transportation drastically reduce CO_2 emissions by spreading them out over many users.
- *Drive a low-carbon vehicle* - High mileage does not always mean low CO_2 emissions. All vehicles have an estimated kilometers-per-liter rating. Electric cars emit no CO_2 if they are charged with clean electricity.
- *Get a hitch-mounted cargo rack* - We should not buy a minivan or SUV if we do not need 4WD and/or will only occasionally need the extra space. A receiver hitch and a rack only cost a few hundred euros. We should avoid roof-top boxes, which cost much more and increase aerodynamic drag, and fuel consumption.
- *Driving style* - Speeding and unnecessary acceleration reduce mileage by up to 33%, waste gas and money, and increase our Carbon Footprint.
- *Tire inflation and other tuning* - Properly inflated tires improve our gas mileage by up to 3%. It also helps to use the correct grade of motor oil, and to keep our engine tuned,

because some maintenance difficulties, like fixing defective oxygen sensors, can increase fuel efficiency by up to 40%.

- *Avoid traffic* - Being stuck in traffic wastes gas and unnecessarily creates CO_2. We should use traffic websites and apps, and use a different way, or wait.
- *Miscellaneous* - We should combine home duties to make fewer trips; we should remove excess weight from our car; we should use cruise control. (COTAP.org - Carbon Offsets To Alleviate Poverty, n.d.)

5.5.2 Air travel

- *General* - Until petroleum-based aviation fuel is replaced, we should avoid flying when possible, fly less frequently, fly shorter distances, and fly economy class.
- *Air travel* is usually the largest component of the Carbon Footprint of frequent flyers. A single return flight from London to New York – including the complicated effects on the high atmosphere – contributes to almost a quarter of the average person's annual emissions. The easiest way to make a big difference is to go by train or not take as many flights.
- *Holiday air travel* - We can take fewer and longer vacations that are far away, and more frequent and drivable "staycations" (a holiday in which we stay at home and visit places near to where we live, or a holiday in our own country) closer to home.
- *Work air travel* - We can increase our use of video-conferencing tools like Skype and Facetime.
- *What class?* - Economy class is best, for the same reasons as carpooling and public transportation. Each flyer's share of a flight's carbon emissions is relatively less because it is spread out over more people.
- *That is economy class* - When Prince William flies economy class, he is leading by example. Then there is Prince Alwaleed bin Talal al-Saud, or the Sultan of Brunei, who buy entire economy-size planes and convert them into flying palaces.
- *Do not fly on private jets* - We should fly first or business class if we *must*, because at least those seats always fill up anyway, and avoid private jets. (COTAP.org - Carbon Offsets To Alleviate Poverty, n.d.)

5.5.3 Making better travel choices

5.5.3.1 Travel light

Whether it is getting to work, going on vacation, or just doing the grocery shopping, how we move about – and what we do at our destination – can have a big impact on the planet.

5.5.3.2 Do we really need to go?

Travelling by any form of transport that uses fossil fuels for energy contributes to climate change. So, the best solution is to avoid such travel wherever possible.

- Instead of popping out every day in the car to run an errand, can we wait and do several errands at once?
- Can our business meeting be replaced by talking over the phone or using video conferencing?
- Can we take our vacation closer to home?

5.5.3.3 Choose the best transport option

Of course, travel cannot always be avoided. We should consider our options and choose the most environmentally-friendly form of transport. We should:

- *Try to drive less.* Can we walk or cycle instead of driving, or use public transport? If we do have to drive, what about carpooling or joining a car-share scheme?
- *Try to avoid plane trips, especially short haul (< 500 km) flights.* Taking the train may even be less of a problem! If air travel is unavoidable, choose airlines with higher occupancy rates and more efficient aircraft. (WWF, 2019)

5.5.4 Purchasing carbon offsets

Individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use, and other sources. For example, an individual might purchase carbon offsets to compensate for the greenhouse gas emissions caused by personal air travel.

Offsets are typically achieved through financial support of projects that reduce the emission of greenhouse gases in the short- or long-term. The most common type of project is renewable energy, such as wind farms, biomass energy, or hydroelectric dams. Others include energy efficiency projects, destruction of industrial pollutants or agricultural byproducts, destruction of landfill methane, and forestry projects. (GENISIS Project, 2017)

Chapter 6 - Results from Measurements, Metrics and Statistics

6.1 Discussion of the results

In this section we will provide the results from the questionnaire responses (see the Annex for Chapter 6) that refer to the four consumption categories, which are: 1. Food; 2. Housing (an object that includes the use of energy); 3. Products and services; and 4. Transport (personal and public transport).

6.1.1 Food

The first component is food (i.e. diet), which includes the consumption of meat, fish, dairy products and eggs. The first seven charts, which are in the Annex for Chapter 6, refer to the seven questions concerning the component of food, i.e. the types of preferred meat, and the purchase of food from domestic production. Of the total number of respondents, 76% consume beef or lamb, 69% pork, 83% poultry, while 86% fish or shellfish, and even 100% consume eggs, cheese and/or dairy products. Regarding the attitude of the students connected with consuming domestic products, it can be concluded that it is more than satisfactory, since 90% of them (Chart 6) give preference to fresh and unpackaged foods from domestic production, and 83 % (Chart 7) for locally-produced food products.

In the standard recommendations related to the promotion of this domain, food from the local environment is given priority (because of lower transport costs and reduced pollution), especially ecologically-produced food.

The Food Footprint element, which among the students is in third place, after the Products and services, and Transport categories, significantly contributed to the increase of the Footprint due to a significant presence of meat products in their diet. In that sense, it is necessary to change their diet, given that the meat industry is one of the significant "greenhouse gases" producers.

6.1.2 Housing

Charts from 8 to 13, which are in the Annex for Chapter 6, refer to the conditions in which the respondents live, including: energy consumption in their residential buildings, energy efficiency, size of the object, material, as well as the number of members, which are the elements that make up the so-called Housing Footprint. Of the total number of respondents, 70% live in a house, while the rest live in an apartment. 30% of the respondents share the housing space with two or three people, while 70% live in larger communities. 99% of the respondents use a housing space that is larger than 45m^2, out of which, unfortunately, 71% are inadequate-to medium-energy-efficient objects, since 94% of them are built of brick or concrete. A large percentage, i.e. 76% of the respondents use electricity from non-renewable sources, while only 24% use electricity from renewable sources. When it comes to the Housing Footprint of the respondents, it is noticeable that the insufficient energy efficiency and the large living space significantly influence the final result, in particular the increased values of the Ecological and Energy Footprints.

6.1.3 Products and services

Charts from 14 to 20, which are in the Annex for Chapter 6, represent the attitude of the respondents to the products and services they use in everyday life - a picture of their Products and Services Footprint, which covers the purchase of certain products, but also the attitude toward those products, that is, to the environment through those products. The consumed product or service takes into account all resources, including the required energy for the product or service to be made available to the consumer. It can be noted that a large number of respondents (86%) buy new clothes, footwear and sports accessories, new household appliances, new electronic devices and accessories, and new furniture, and 77% buy books, magazines and newspapers. This consumer behavior increased the total Ecological and Energy Footprints, which was even further enlarged due to the fact that 60% of the respondents do not recycle paper and plastic at all. Excessive consumption leads to pollution, that is, to the accumulation of waste, which should be selected and recycled. The results of the questionnaire indicate that consumption is excessive, while recycling is not sufficiently represented.

Given that personal waste constitutes 30% of global waste, with a reduction of their Products and Services Footprint, the respondents will make a major contribution to the reduction of waste on our planet.

6.1.4 Transport (personal and public transport)

Charts from 21 to 26, which are in the Annex for Chapter 6, relate to the usual habits of the respondents when it comes to shipping, or the type of transportation vehicle that they most often use. It was discovered that in 86% of the respondents, the most frequently-used personal transport vehicle is the car, with an average consumption of 6.5 liters per 100 km, but, unfortunately, 67% of the respondents very rarely carpool (ride in the same car with other passengers). As far as public transport is concerned, as many as 86% of the respondents do not use rail transport, while 94% use the bus. As a result of using cars with increased consumption, the Energy Footprints of transport occupies the second dominant place in the overall Ecological Footprint. Additionally, it was enlarged owing to bus transport and airplane flying.

The use of personal transport puts "the greatest stamp" on the Energy Footprint because it leads not only to increased costs, but also to the release of large amounts of CO_2 in the atmosphere, and it is precisely such transport that the respondents favor. It is recommended that priority should be given to public transport in relation to personal transport, and, of course, to replace public and private transport by cycling or walking wherever possible.

6.2 Observations from the results

Based on Table 5, the results reveal that the university students' average Total Ecological Footprint is two times bigger (6.45 gha) than the Macedonian national average (3.1 gha). Furthermore, most of their Ecological Footprint comes from their Energy Footprint (65%).

	All	Male	Female	National
Total Ecological Footprint (gha)	**6.45**	**6.47**	**6.42**	**3.10**
Energy Footprint (gha)	**4.22**	**4.21**	**4.23**	**2.20**
Carbon Footprint (CO_2 emissions in tons per year)	**12.26**	**12.24**	**12.28**	**5.10**
Energy Footprint (% of total Ecological Footprint)	**65%**	**65%**	**65%**	**61%**

Table 5 - Final results from the analysis

As can be seen from Figure 4, according to the consumer categories, the most important share in the Total Ecological Footprint is held by the following three categories: Products and Services (3.53 gha), Transport (1.26 gha) and Food (0.89 gha).

6.3 Gender analysis of respondents' Ecological and Energy Footprints

University students were used as subjects because they are understood to be the future managers of our natural resources. There is an equal number of 35 male and 35 female respondents. Their average age is 19 years old. The average age was expected given the fact that the respondents are students. The youngest respondent is 18 years old, while the oldest is 22 years of age.

The Ecological Footprint approach was applied to compare the environmental impacts between genders. The same web-based software created by the Global Footprint Network was used to convert the consumption data into its equivalent Footprint values.

Gender wise, the male respondents have a slightly higher personal Ecological Footprint (6.47 gha) than the female respondents (6.42 gha). It should be noted that most of the Ecological Footprint from the respondents (both male and female) is attributed to their Energy Footprint (65%). This can be explained by the fact that students are more likely to purchase products and services, as well as travel (which entails a larger share of resource consumption which produces CO_2 emissions).

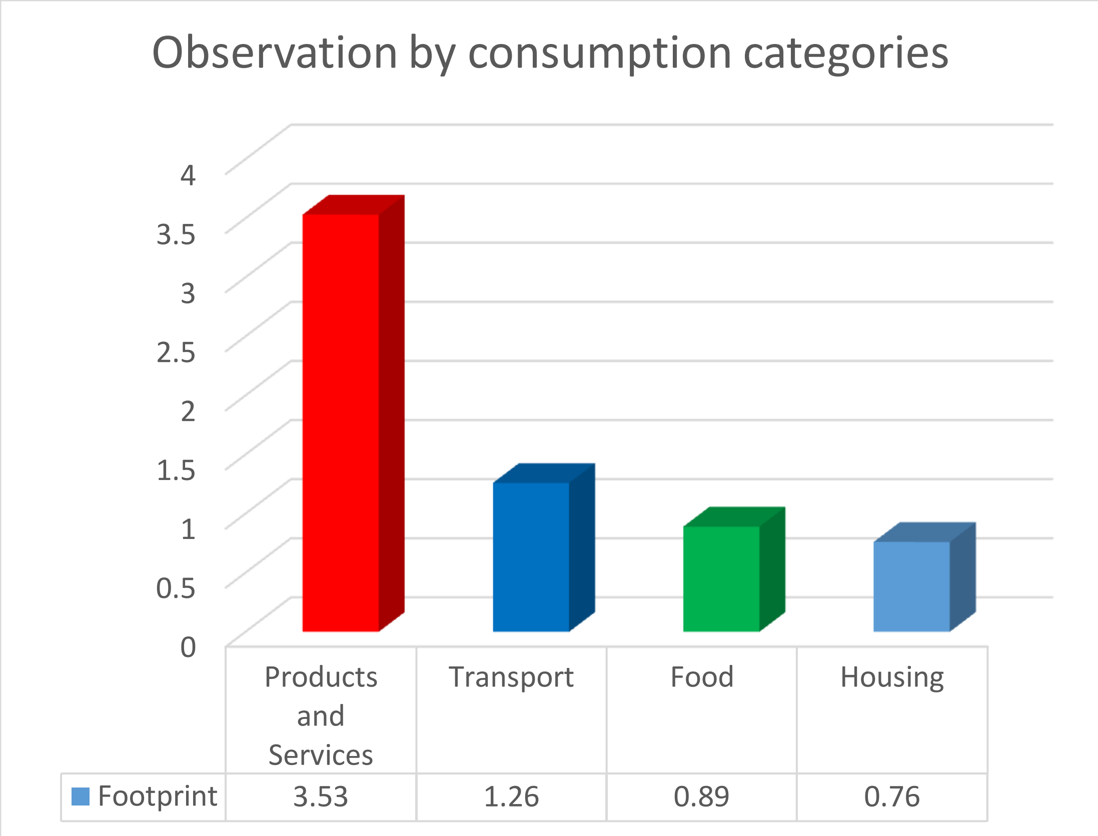

Figure 4 - Ecological Footprint of the respondents by consumption category

As can be seen from Figure 5 below, according to the types of land, the largest share in the Total Ecological Footprint of our respondents is due to the forest land needed to absorb the carbon dioxide (4.22 gha).

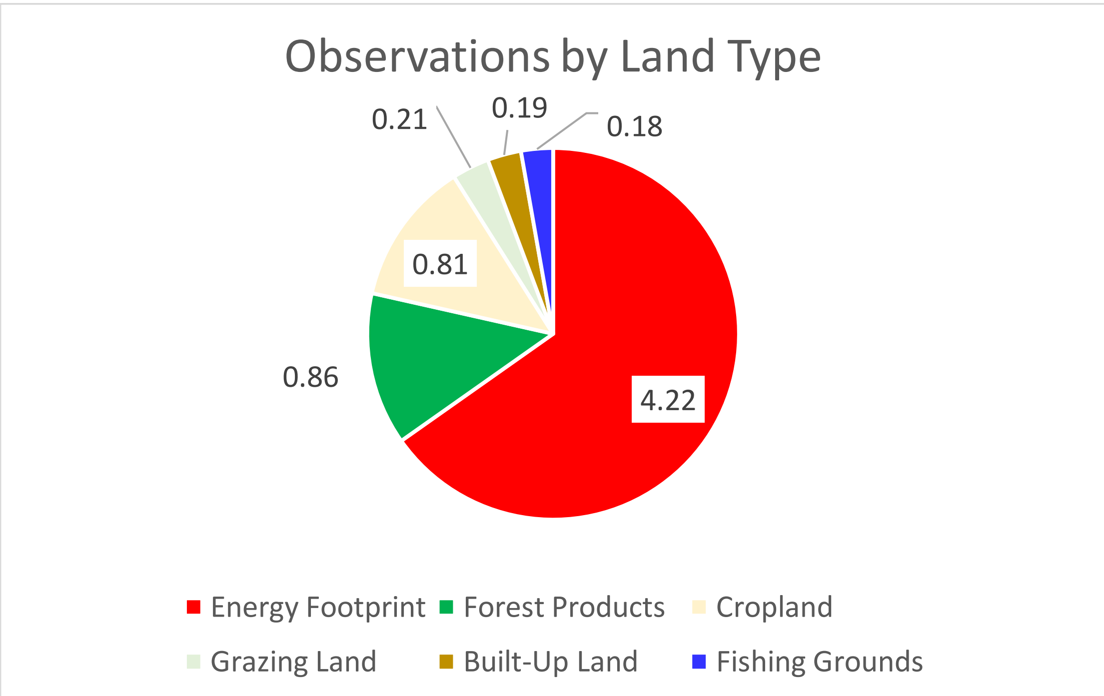

Figure 5 - Ecological Footprint of all the respondents by land type

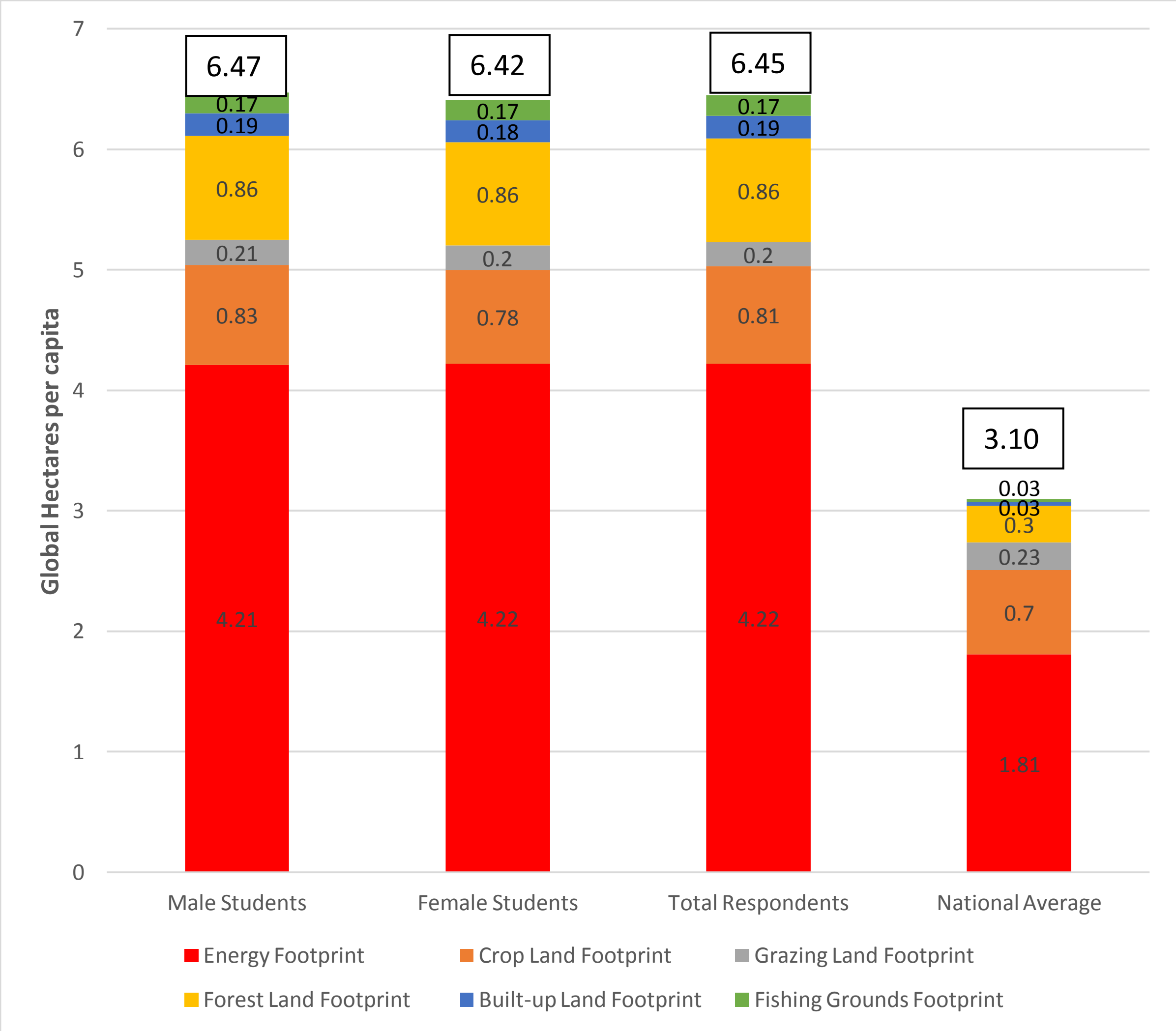

Figure 6 - Ecological Footprint land use components of the respondents as compared with the national average (gha/capita)

Furthermore, it is also noticeable that the respondents' Ecological Footprint percentage coming from the Forest Land Footprint (0.86 gha) is three times higher than the percentage of the same Ecological Footprint component at the national average of North Macedonia (0.3 gha). This can be explained by the nature of the occupation of the students, who tend to use more paper products (leading to a higher Forest Land Footprint), as compared to the average citizen of North Macedonia. Moreover, an almost equal (if not the same) percentage distribution can be observed in terms of the Grazing Land Ecological Footprint component. This means that in terms of resource consumption based on grazing/pasture land (i.e. dairy products), the respondents' consumption behavior is representative of the average citizen of North Macedonia.

Based on gender, in both groups there is an almost equal distribution of Ecological Footprint components from the total Ecological Footprint, except for the Energy Footprint, where the female respondents have a slightly higher Ecological Footprint (4.23) as compared to their male counterparts (4.21). This difference only slightly contributed to the statistical difference in the Ecological Footprint among the male and female respondents.

6.3.1 Comparison of respondents' Ecological Footprint in terms of gender

In Table 6 below, in terms of the total Ecological Footprint, it is revealed that the total Ecological Footprint of the male respondents (6.47 gha) in the study is slightly higher than that of the female respondents (6.42 gha).

Ecological Footprint Component	Male Respondents' Average Ecological Footprint	Female Respondents' Average Ecological Footprint	National Average Ecological Footprint
Built-up Land Footprint	0.19	0.18	0.03
Forest Land Footprint	0.86	0.86	0.30
Crop Land Footprint	0.83	0.78	0.70
Grazing Land Footprint	0.21	0.20	0.23
Fishing Grounds Footprint	0.17	0.17	0.03
Energy Footprint	4.21	4.23	1.81
Total average Ecological Footprint	6.47	6.42	3.10

Table 6 - Statistical comparison of the Ecological Footprint between the male and female respondents

Consumption has always been interpreted as gender-based. For instance, generally in terms of transport, men's travels are more often due to work or business reasons, while women mostly take trips that involve household chores, hence, they use public transport more often.

In our case, in terms of carbon emissions there is almost no difference between the male and the female student respondents.

Furthermore, in terms of the specific land use components, the female respondents have a slightly higher Energy Footprint (4.23 gha) than the male respondents (4.21 gha). This means that the female respondents have slightly higher CO_2 emissions based on their lifestyle, because of their frequent use of cosmetics (such as hairspray, deodorants, perfumes), cleansers, etc. It indicates a somewhat more carbon-intensive consumption pattern for females as compared to males.

Additionally, there were no significant differences found between the male and the female respondents in terms of the rest of the Ecological Footprint land use components (Built-up Land, Forest Land, Grazing Land, and Fishing Grounds), except for the Crop Land Footprint. Probably by consuming more meat (e.g. beef, lamb or pork) this leads to the male respondents having a higher Crop Land Footprint (0.83 gha) than the female ones (0.78 gha). This means that there is an almost equal degree of ecological impact among the male and the female respondents of the study in terms of their demand for the land use components.

6.3.2 Gender analysis conclusion

The study results show that the respondents' total Ecological Footprint (6.45 gha) is double the national total Ecological Footprint average (3.1 gha), which means that the respondents' impact on the environment is far greater than the impact of the average citizen of North Macedonia based on lifestyle and resource consumption. Based on Chart 29, the major contributor of the respondents' Ecological Footprint is their Energy Footprint (4.22 gha, or 65% of the total Ecological Footprint 6.45 gha), which is somewhat different on a national scale, where it is also the highest contributor (1.81 gha, or 61% of the total Ecological Footprint 3.1 gha) to the national Ecological Footprint average. This means that the students' consumption pattern is characterized by an equal carbon-intensive lifestyle as the majority of citizens of North Macedonia. Furthermore, it should be noted that students demand three times more forest-based products as compared to the average citizen of North Macedonia. This implies that the students need to be more responsive to the call for resource conservation. It is an opportunity for the university administration to realize its vision for sustainability through relevant programs and projects based on the above results. Furthermore, in terms of gender, it was found that male students are slightly more resource-intensive as compared to female students. Though they are revealed to have no differences in their demand for most of the different land use components, they differ to some extent in their Crop Land Footprint. Thus, this study confirms that the male respondents have a higher Crop Land Footprint (0.83 gha) than the female ones (0.78 gha) due to consuming more meat.

Hopefully the above information revealed in the study will help the Faculty in its future directions for a more sustainable university. Moreover, the students need to think on a personal level about how they can reduce their impact on nature. As the study suggests, reduction of carbon intensive activities and consumption, as well as a decrease of their dependence on forest, and crop-land based products can be a practical way to reduce their personal ecological impact. In light of our present dilemma with the emergence of climate change in which greenhouse gases are the main cause, it is alarming that the students at the university are shown to have a greater impact in terms of carbon emissions as compared to other types of environmental impacts. This essentially calls for a thorough and massive information dissemination with regards to Energy Footprint reduction, as well as to a promotion of sustainable lifestyles around the campus, such as walking or biking rather than driving, consuming organic foods, energy conservation, etc. In this context, the Ecological Footprint can be an educational tool aside from being a policy tool, especially for climate change mitigation, as well as for addressing natural resource degradation.

6.4 Respondents’ reactions after completing the questionnaire

To express our gratitude for their participation in the research, as well as their great interest in the questionnaire, we promised the respondents that we would individually give them the ready results for their Ecological Footprint (Enclosure PDF File: 01-70_All Respondents Footprint Summary.pdf). After the students saw their Ecological Footprints and compared the size of the Ecological Footprints of the other respondents, and as a result of that comparison, they doubted that the Earth would have the capacity to maintain the human population if all the inhabitants applied their lifestyle.

They were mostly intrigued and fascinated by the measuring of the Ecological Footprint according to the number of planetary equivalents. They did not believe that such a number of planets would be needed if all people had an Eco-Footprint like theirs. The students expressed a desire to measure their Ecological Footprint on the internet ecological calculator. The calculator offers a concrete insight into their personal impact on the Earth, and, at the same time, it is a way of assessing sustainability by their lifestyle. The engagement of the respondents for an independent analysis of their Ecological Footprint prompted curiosity, enthusiasm and an initiative to reduce using up nature. They liked the fact that the analysis focused on their own lives, understood the clear message that their own choice is important, and, finally, that they themselves can contribute to change.

Calculating their own Ecological Footprint strengthened in them the idea that sustainability is a process and not an immediate action, and that they should be active participants in it rather than passive observers. The measurement of personal dependence on nature (usually at a daily level) offered the respondents a new understanding of the interconnectedness of personal everyday habits and the health of the planet.

It awoke their motivation to reduce their individual Ecological and Energy Footprints.

What is the motivation to reduce one’s individual Ecological Footprint? If there is no target to achieve, then an individual can never do enough; their efforts would probably tend to increase and decrease over time but, more importantly, highly-motivated individuals would always feel guilty that they are not doing enough. In addition to having targets to meet, perhaps some kind of positive motive needs to be included, too, so that individuals can justly somehow reward themselves when they achieve certain milestones (success).

Chapter 7 - Conclusion

The global community is using natural resources very intensely, at rates exceeding nature's ability to regenerate their productivity potential. Economically-developed countries throughout the world should prepare a new sustainable development strategy including the marked development of renewable natural resource production, as well as effective implementation of various environmental protection measures.

At present, the world is combating the financial crisis which was the result of the over-evaluation of the potentials of financial resources and their relatively excessive use. However, humanity may one day face another fundamental global crisis as a result of its "ecological debt", inadequate understanding of the importance of sustainable development, and out-of-control consumption of natural resources. The implementation of systematic environmental educational programs, adapted to children, businesspeople, employees of governmental institutions and society, should be the aim of all governments.

The aspects that were discussed in this thesis are intended to help individuals, particularly researchers, as factors of change in the sustainability transition. We have shown a structural diagram (see page 5) for connecting the sustainability objective of inter-generational well-being to five basic capitals that primarily establish society's capacity to satisfy those objectives. We provide reasons for the importance of noticing and recognizing the multiple co-operation in the social, environmental, and energy structure in which striving toward sustainability takes place. We propose that respect is required for the administration processes through which contracts and resolutions are created, permitting society to achieve in partnership what cannot be achieved with their own efforts. And, eventually, we focus on the ways that applicable knowledge, equipment, and attitude can be expanded in co-operation with decision-makers and other participants at all positions.

During the time that these common aspects are intended to be a model to assist individuals to understand, specify and confront the special sustainability and energy management problems that they come across in their individual and business existence, they are not, on their own, sufficient. They are only a fragment of a bigger mechanism required to make advancements toward sustainability. Every person has in their mechanism a group of a particular sets of abilities and some awareness, gathered from knowledge and school-days, and a way of thinking that makes them prepared to make contributions in important ways.

The task is not finished, and it never will be; however, there is no doubt that success is achieved in the process of shifting to energy efficiency and sustainability. Sustainability is not a thing to be accomplished, but it is a thing that we should direct ourselves toward. The Earth and society are different, new problems continue to appear, and the race continues, but some apparently sophisticated things, unfortunately do not succeed. However, each step forward is important, and should be undertaken as soon as possible. Good wishes are insufficient; everyone should make subsequent moves toward energy efficiency and sustainability. Marshall McLuhan very eloquently put it: “There are no passengers on the Spaceship Earth. We are all crew.” This means that all people, as part of the biosphere, have a great responsibility in view of the deliberately planned activity that affects its integrity.

In an emerging sustainability science, much work has been done on indicators of sustainable development. Perhaps, more work has been done on this topic than on any of the other basic questions of sustainability science. Yet, to date, there are no indicator sets that are universally accepted, backed by convincing theory, precise data collection and analysis, and influential in policy. Why is this so? We offer three major reasons:

a. the enigma of sustainable development;
b. the large number of purposes in characterizing and measuring sustainable development; and,
c. the confusion of terminology, data, and methods of measurement. (Parris & Kates, 2003)(p. 581)

The Ecological and Energy Footprints as indicators of sustainability and energy management are most useful as tools for communication. They help to simplify the concept, and are a starting point to provide a practical direction for a lifestyle change. An Ecological Footprint calculation provides a baseline from which to measure progress toward a smaller Footprint, and a more sustainable lifestyle. The Personal Ecological Footprint Calculator assumes that the habits identified reflect how one always lives; however, we know that lifestyle is influenced by factors such as a person's age or time of year, and an Ecological Footprint will expand or shrink accordingly. The inevitable conclusion is that less is more; we all need to shrink our Ecological and Energy Footprints.

This research has revealed that the concept of sustainability is still perceived superficially among both student representatives and specialists in governmental institutions responsible for the sustainable development policies of the country. Our results from the questionnaire have shown a low understanding among students about the Ecological and Energy Footprints as indicators of sustainable development and energy efficiency. Therefore, scientific studies on issues concerning the Ecological and Energy Footprints, and their public awareness, are very important.

There is little knowledge about the concept of the Ecological Footprint in North Macedonia, and literature that would spread knowledge about it barely exists in Macedonian. The application of most of the principles related to environmental awareness, such as the introduction of the principles of social responsibility, sustainable development, ethical consumption and purchasing and recycling are still in the initial stages of development.

The current or initial results of the conducted research on the values of the Ecological and Energy Footprints of the English language students at the Faculty of Philology at UKIM in Skopje are not at the level that would constitute a so-called sustainable society, because many of the respondents are literally addicted to modern conveniences that they surround themselves with.

The results of the specific research carried out for the needs of this paper confirm that the problems of sustainable development and energy management are of a global nature, but that their resolution should begin at the lowest, most specific local level, and that they depend on each individual.

It is an undeniable fact that a very stressful and fast “pace of living” prevails in most regions on the planet. But a very small percentage of people would replace it with a lifestyle from the distant or near past. However, with certain and fairly radical adjustments to students' daily habits, this value could become acceptable, i.e. would be "a support" for the sustainable development of the planet.

We believe that by raising awareness about sustainable development and energy efficiency, and then by adjusting the "unsustainable habits" and changing attitudes toward nature and its resources, the desired goal will be achieved, and that is development in accordance with the principle of sustainability and energy management.

The aim of this thesis is to prove that the present way and rhythm of living is not sustainable. There are many approaches that governments and industry can take to reduce environmental degradation. However, one of the most difficult issues to address is how to change the day-to-day behavior of individuals. (McDonald, et al., 2012) How can each of us, as individual agents, contribute to the pursuit of sustainability and energy efficiency? This, then, leads to the question of what targets should apply to individuals. The issue of targets ties in with matters of motivation. The general public is motivated to participate in EIA (Environmental Impact Assessment) processes because of a given self-interest (for instance, in an attempt to stop an undesirable project from making progress, or at least change it into something that is acceptable). We should point out that this research did motivate us to make some immediate changes to our lifestyle, including eating less meat, saving water, signing up for energy star appliances, carpooling, and reusing, reducing and recycling.

Annexes

Annex for Chapter 1

Throughout the 1980s and particularly in the 1990s, a series of high-profile summits, such as the United Nations Conference on Environment and Development in Rio (1992) and the World Summit on Sustainable Development in Johannesburg (2002), and growing concern over climate change, such as the United Nations Environment Programme and the World Meteorological Organization establishing the Intergovernmental Panel on Climate Change (1998), and the adoption of the Kyoto Protocol (1997), meant that there was widespread recognition of the scale and significance of environmental change. Here is a complete review of the summits (Conventions and Declarations) of global importance. (United Nations, 2019)

Declarations and Conventions for Sustainable Development

- United Nations Conference on the Human Environment (UNCHE), Stockholm, 1972;
- United Nations Conference on Environment and Development (UNCED), Rio de Janeiro Earth Summit, Rio de Janeiro, 1992;
- United Nations Framework Convention on Climate Change (UNFCCC), Rio de Janeiro, 1992;
- Millennium Summit, New York, 2000;
- World Summit on Sustainable Development (WSSD), Johannesburg 2002;
- United Nations Conference on Sustainable Development (Rio+20), Rio de Janeiro, 2012.

United Nations Conference on the Human Environment (UNCHE), Stockholm, 1972

The UNCHE or Stockholm Conference, held in Stockholm, Sweden from 5 to 16 June, 1972, was the UN's first major conference on international environmental issues. Attended by representatives of 113 countries, it is widely recognized as the beginning of modern political and public awareness of global environmental problems. Stockholm represented a first assessment of the global human impact on the environment, an attempt on how to deal with the challenge of preserving and improving the human environment.

The main achievement of the Conference is the adoption of the:

Declaration of the United Nations Conferences on the Human Environment

The Declaration contains 26 principles to inspire and guide the countries of the world in the preservation and improvement of the human environment. It adopts mainly broad environmental policy goals and objectives rather than detailed controlling positions.

United Nations Conference on Environment and Development (UNCED), Rio de Janeiro Earth Summit, Rio de Janeiro, 1992

The United Nations Conference on Environment and Development (UNCED), also known as the Earth or Rio Summit, was held in Rio de Janeiro from 3 to 14 June, 1992. It was attended by representatives from 172 countries. The central focus was the question of how to reduce the global environmental pressure and poverty through the introduction of the paradigm of sustainable development. This concept emphasizes that economic and social progress depend basically on the preservation of the natural resource base with effective measures to prevent environmental degradation.

The main achievements of the UNCED included: the Rio Declaration, declaring 27 principles of environment and development, Agenda 21, and a Statement of Forest Principles, a set of principles for the sustainable management of forests. The last were all adopted by agreement at the conference.

The institutional innovation resulting from the conference included an agreement on the operating rules for the Global Environmental Facility (GEF), and the creation of the United Nations Commission on Sustainable Development (CSD) on the basis of an Agenda 21 recommendation.

a) Rio Declaration on Environment and Development

The Rio Declaration on Environment and Development is a set of 27 legally non-binding principles designed to commit governments to ensure environmental protection and responsible development. The Declaration includes many progressive approaches, such as ‘the polluter pays principle’ (the polluter bears the costs of pollution), and the precautionary approach (Principle 15. “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”). This Declaration has promoted the development of an international environmental legislation and the progressive definition of customary international environmental laws.

b) Agenda 21

Agenda 21 is a program of implementation for sustainable development; it created the global environmental agenda for the next 20 years. It encompasses 40 chapters, divided into four main sections: Social and Economic Dimensions, Conservation and Management of Resources for Development, Strengthening the Role of Major Groups, and Means of Implementation.

Chapter 17 supports Small Island Developing States (SIDS) and its coastal areas as a special case.

Agenda 21: 17.124. "Small Island Developing States, and islands supporting small communities are a special case both for the environment and for development. They are ecologically-fragile and vulnerable. Their small size, limited resources, geographic dispersion, and isolation from markets place them at a disadvantage economically ".

Agenda 21 also called for a global conference on the sustainable development of SIDS.

c) Capacity 2015

Capacity 2015: Building capacity to benefit from globalization and realize the Millennium Development Goals while achieving sustainable development is a broad-based partnership at the local, national, regional and global level. It is built upon experience gained during the ten years since UNCED started to help countries to move from strategic planning for sustainable development to effective implementation. It helps countries to see the benefits of globalization, make sure that processes of sustainable development put in place during the 1990s are utilized to face the challenges of the XXI century, and strengthen the capacities needed to achieve or exceed the Millennium Development Goals.

UN Framework Convention on Climate Change (UNFCCC), Rio de Janeiro, 1992

The global climate change issue is addressed by the United Nations Framework Convention on Climate Change (UNFCCC) (UN, 1992). The convention was adopted in New York in May, 1992, and was signed at the Rio de Janeiro Summit in June of the same year. The Convention came into force in March 1994, and today it has 192 participants.

The ultimate objective of this Convention is to establish the stability of the greenhouse gas concentration at a level that will prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a timeframe sufficient to allow eco-systems to adapt naturally to climate change, to ensure that food production is not compromised, and to allow further economic development in a sustainable manner.

Millennium Summit, New York, 2000

At the Millennium Summit, held from 6 to 8 September, 2000, the world leaders adopted the UN Millennium Declaration, and, in doing so, resolved to address the special needs of SIDS by implementing the BPOA (Barbados Programme of Action).

The main document, unanimously adopted, was the Millennium Declaration.

a) Millennium Declaration

The Declaration contains a statement of values, principles and objectives for the international agenda for the XXI century. It also sets deadlines for many collective actions. The document also insists that every individual has the right to dignity, freedom, equality, a basic standard of living that includes freedom from hunger and violence, and encourages tolerance and solidarity.

b) Millennium Development Goals

The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty rates to stopping the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a plan agreed to by all the world's countries and all the world's leading development institutions.

The Millennium Development Goals are: (1) to eliminate extreme poverty and hunger; (2) to achieve universal primary education; (3) to promote gender equality and emancipate women; (4) to reduce child mortality; (5) to improve maternal health; (6) to combat HIV/AIDS, malaria, and other diseases; (7) to ensure environmental sustainability; and (8) to develop a global partnership for development.

World Summit on Sustainable Development (WSSD), Johannesburg, 2002

The WSSD recognized sustainable development as the most important goal for institutions at the national, regional and international levels. The concept of sustainable development has been based on the idea that economic development, social development and environmental protection are three strongly related elements that need to be considered together. The major results of the Summit are: the adoption of the Declaration on Sustainable Development and the Plan of Implementation; the confirmation of SIDS as a special case; and the creation of on-negotiated partnerships for sustainable development.

a) Johannesburg Declaration on Sustainable Development

The Johannesburg Declaration is an agreement to focus particularly on "the worldwide conditions that present very strong threats to the sustainable development of our people, which include: chronic hunger; malnutrition; foreign occupation; armed conflict; illegal drug problems; organized crime; corruption; natural disasters; illegal arms trafficking; human trafficking; terrorism; intolerance and provocation to racial, ethnic, religious and other hatreds; xenophobia; and local, communicable and chronic diseases, in particular HIV/AIDS, malaria and tuberculosis. These threats also obstruct in helping the objective of environmental protection".

b) Johannesburg Plan of Implementation of the World Summit on Sustainable Development (JPOI)

The JPOI is the more action-oriented document adopted by the Summit. It once again confirmed the dedication to sustainable development, assuming a collective responsibility to advance and strengthen the interdependent and mutually-reinforcing pillars of sustainable development - economic development, social development and environmental protection - at the local, national, regional and global levels. Similarly to Agenda 21 (Rio de Janeiro, 1992), the Plan of Implementation is divided into several chapters, covering the various aspects of sustainable development. For each broad topic, there are several dozen recommendations. One chapter is dedicated to the sustainable development of SIDS.

UN Conference on Sustainable Development (Rio+20), Rio de Janeiro, 2012

The UNCSD marked the 20th anniversary of the Earth Summit, with participation from 192 UN member states. Progress toward the goals set out in Agenda 21 was reviewed, identifying implementation gaps and discussing new and emerging issues. Political commitment for sustainable development was renewed. The conference focus was on two themes: the green economy in the context of sustainable development, and the institutional framework for sustainable development.

a) The Future We Want

This is a non-mandatory document, reaffirming political commitment to sustainable development and the promotion of a sustainable future, reaffirming Agenda 21 and other previous action plans.

b) Sustainable Development Goals

One of the main results of the Rio+20 Conference was the agreement by member states to start a process to develop a set of Sustainable Development Goals (SDGs), which will build upon the Millennium Development Goals and connect with the post-2015 development agenda.

c) Pacific Plan 2005

The Pacific Plan is the master strategy for regional integration and coordination in the Pacific. It is a high-level framework that guides the work of national governments, regional agencies and development partners, and was supported by leaders in Port Moresby in October, 2005.

Annex for Chapter 2

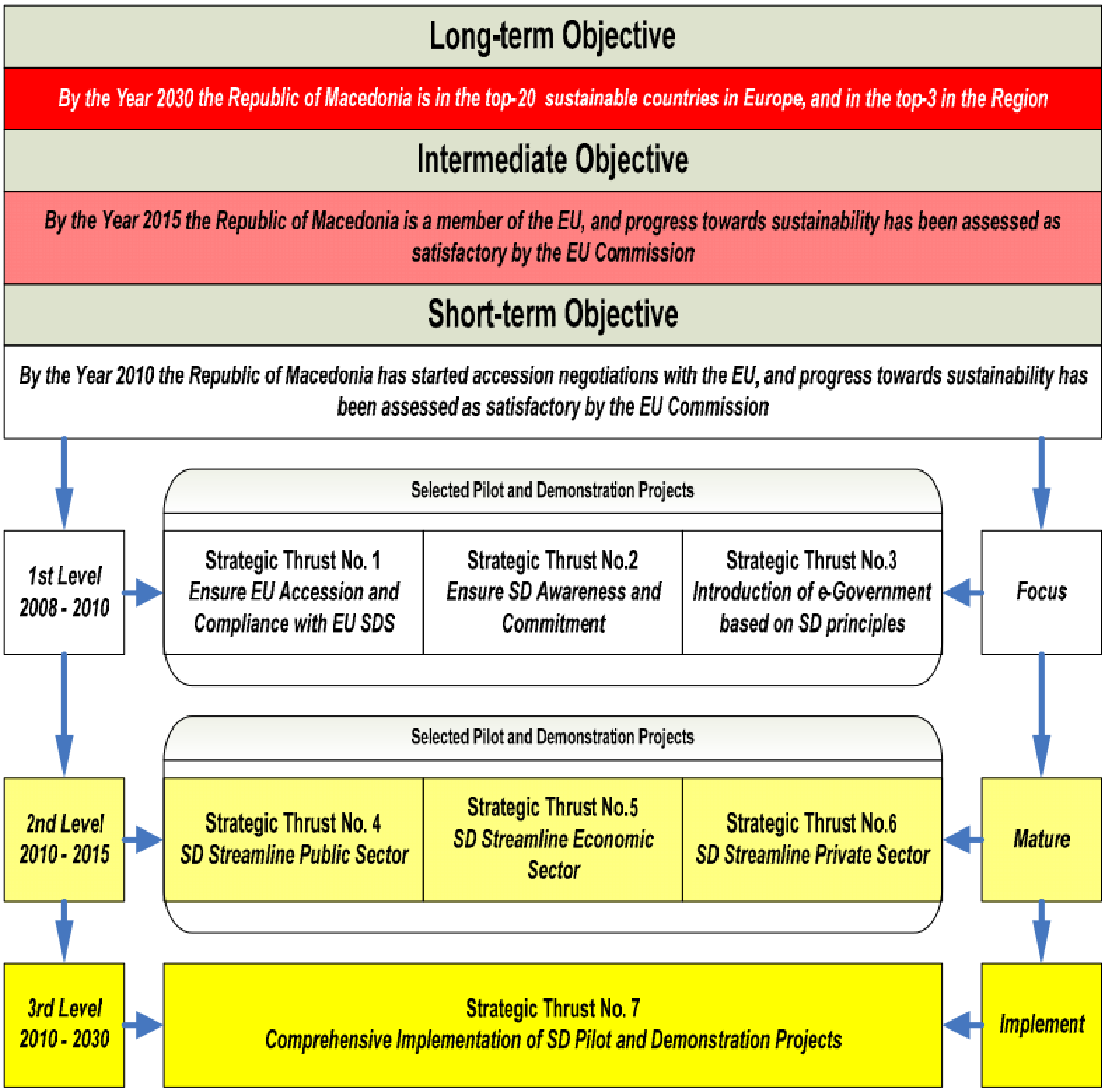

Figure 7 - National Sustainable Development Strategy in the Republic of North Macedonia (NSSD Project Team, 2008)(p. 19)

Annex for Chapter 4

How much Earth do we have and what is Fair Earth Share?

By using an apple to represent the Earth, we would like to point out how small the area of the Earth that has the topsoil is to produce the food on which we depend. Let us cut the Earth into four pieces. Now, let us throw out three of the pieces that represent the oceans. Oceans make up 75% of the Earth's surface area. Let us slice the remaining piece of Earth in half and throw out one piece representing lands, such as deserts, which are unfriendly. What is left is 1/8 of the apple. But that is not the amount available to us. Let us slice the 1/8 into four sections and throw out three of them. These represent areas that are too cold, too steep, or too rocky to produce food. Let us peel the skin of the remaining 1/32 slice of the apple and throw out the rest. This small amount of skin represents the Earth's crust, the area that has enough topsoil to produce the food on which we all depend. The Earth's topsoil is only 1.5 meters deep on average, and produces a relatively fixed amount of food. Over-farming and erosion take away billions of tons of topsoil each year. Each 2.5 cm of topsoil takes on average 100 years to form.

The Earth does not seem quite as big anymore, does it? Natural resources are limited and must be used wisely so that all of us can live on this small piece of the Earth. (Institute for Sustainable Energy, n.d.)(p. 4)

The amount of biologically-productive land on Earth is in decline owing to urbanization, overgrazing by livestock, deforestation, toxic contamination, poor agricultural practices, desertification, and global climate change.

We should remind ourselves that the limited amount of biologically-productive land that supports us also needs to provide food, water, and shelter for more than 10 million other species. We should consider, too, the implications of living in a world where 80% of the human family use 20% of available resources, while 20% (i.e., those in wealthier countries) use 80% of available resources.

The human population is 7.2 billion and increasing. Of the biologically-productive land and water that is available, our average Earth share is 1.7 hectares per person (not including the needs of all other life forms). As our population grows, we must either reduce our average Earth share, or find more Earths to inhabit.

Fair Earth Share

If we were to divide all the bio-productive land and sea available on the Earth by the number of humans seeking to use it, we would arrive at the "Fair Earth Share." That is, we would arrive at the amount of land it would be fair for us to take if we assumed that each person deserved the same amount. That number (during the first decade of the XXI century) is 1.7 hectares. Thus, everyone on the Earth —including us — has 1.7 hectares with which to handle all energy, material, and waste needs.

- How much water do I use on a typical day?
- What do I eat and how much do I eat?
- How much food do I waste?
- What means of transport do I use and how far do I go?
- How much clothing and footwear do I have and how often do I replace it?
- What and how much stuff do I buy?
- How much energy and materials are required to keep me dry and warm/cool?
- How much garbage do I produce?
- How much land and energy is used for my recreational activities?

Each of us consumes some of the Earth's products and services every day. How much we take depends on the ways in which we satisfy our needs and wants — the many habits that together create our lifestyle. We can ask ourselves these questions to get a better sense of what these habits are (Turner, n.d.):

Our answers to these questions reflect the demand that each of us places on nature. In the 1990s, sustainability gurus Mathis Wackernagel and William Rees coined the term "Ecological Footprint". The term Ecological Footprint is used to refer to the load or demand that we place on the Earth's resources. An Ecological Footprint is a measure of how much of the Earth's biologically-productive land (arable land) and water is needed to produce our food, material goods, and energy, and to absorb our waste.

The Ecological Footprint is measured in global hectares (gha). A global hectare is one hectare of biologically-productive space with an annual productivity equal to the world average. Currently, the biosphere has approximately **12.2** billion hectares of biologically-productive space corresponding to roughly one quarter of the planet's surface. These biologically-productive hectares include **1.1** billion hectares of ocean and inland water, and **11.1** billion hectares of land. The land space is composed of **0.46** billion hectares of built-up land, **5.2** billion hectares of forest land, **3.99** billion hectares of cropland, and **1.5** billion hectares of grazing land. These surfaces represent the sum total of biologically-productive hectares we rely on for our survival. They represent the Earth's natural capital, and their annual yield represents our annual natural capital income.

Due to the differences in lands productivity, global hectares aid in comparing land with different productivity. For instance, 1 ha built-on areas are 2.2 gha; 1 ha forests is 1.4 gha; 1 ha of grain (crop land) is equated to 2.1 gha; 1 ha of pasture (grazing land) is 0.5 gha; 1 ha fishing grounds is 0.4 gha, etc. (Calculation, 2010) (Global Footprint Network, 2010). This means that 1 ha of productive land is not equal to 1 ha of a desert, and a country with more productive land will have more global hectares, in other words, it will be able to create more value from the land it possesses.

Because trade is global, an individual's or a country's Footprint includes land or sea from all over the world. A global hectare is a measurement of the average biocapacity of the Earth, based on resource manufacture and waste assimilation, that is, the Earth's biologically-productive area of land and marine zones expressed in hectares. All these elements are parts of the Ecological Footprint. The Ecological Footprint is a sum of the Ecological Footprints of all these elements. First of all, the elements of the Ecological Footprints are calculated, and their sum constitutes the total Ecological Footprint of the population at hand.

We would like to illustrate how we can relate our everyday consumption of food with the use of the Earth's biologically-productive land. In practice, calculating an Ecological Footprint is an exercise in accounting: consider the common hamburger that you might order at a fast-food joint (ignoring, for the time being, the burger's bun and ketchup). The beef patty came from a young bull. During its early life, this young bull required land to graze on, and, later, when it was being fattened in a feed lot, land was needed to grow the young bull's feed. This young bull was killed and processed at a meat-packing plant and this required both land (for the facility) and energy (to power the plant). Next, the processed beef patty was transported to a local fast-food restaurant. Here, too, land (for roads, parking, etc.) and energy (for transportation) were required. Still more energy was needed in the restaurant for both refrigeration and cooking. Expressing the various components of our hamburger's ecological history in terms of land area and then summing up these components would provide the Ecological Footprint of this burger. (Uhl, 2003)(p. 175)

Biocapacity and Ecological Footprint

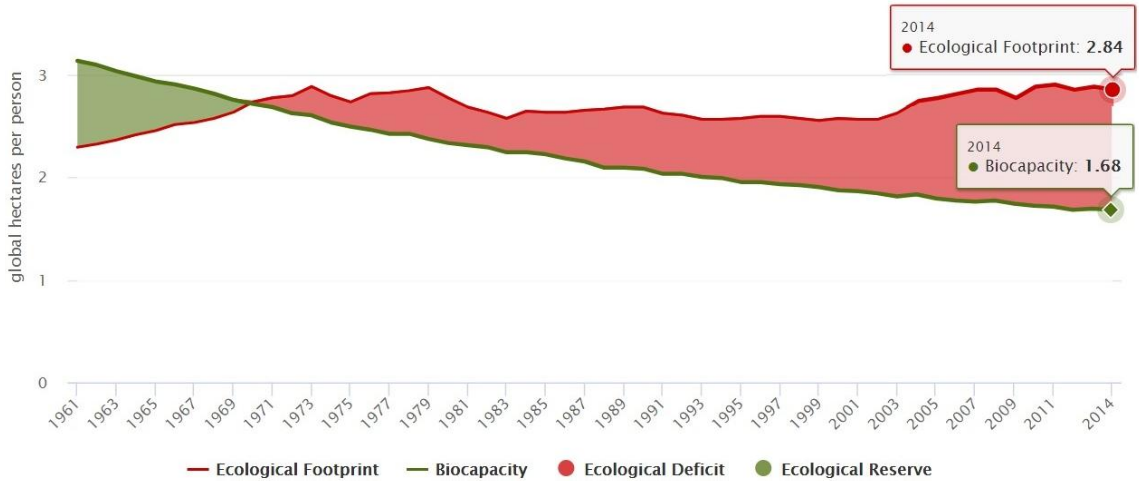

Figure 8 - Ratio of Biocapacity and Ecological Footprint expressed in global hectares per person (Global Footprint Network, 2018)

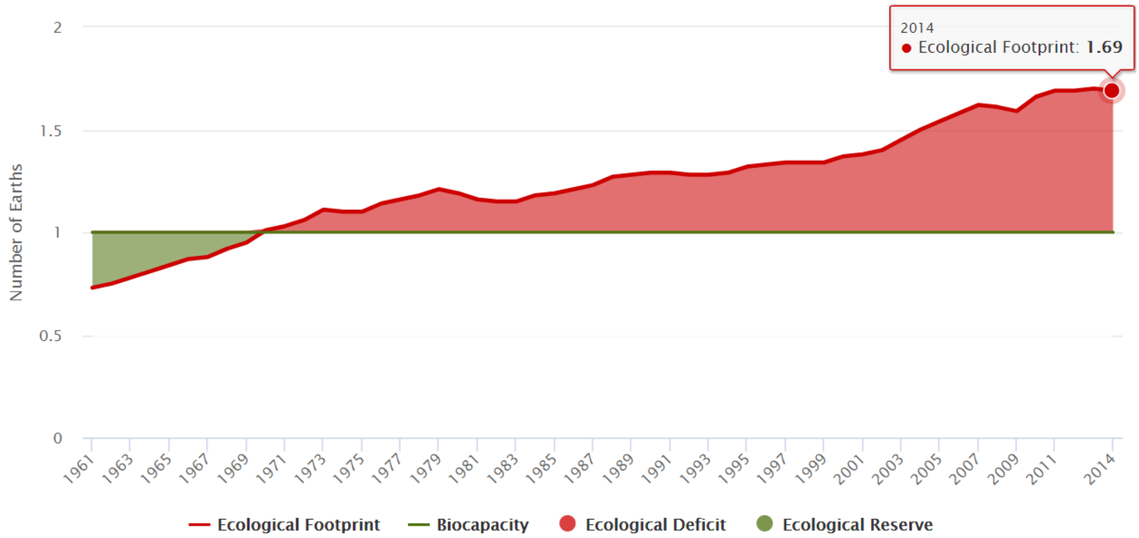

Figure 9 - Ratio of Biocapacity and Ecological Footprint expressed in planet equivalents (Global Footprint Network, 2018)

N°	**Country**	**Ecological Footprint** (gha/person)	**N°**	**Country**	**Ecological Footprint** (gha/person)
1	Qatar	15.7	180	Malawi	0.8
2	Luxembourg	12.3	181	Bangladesh	0.8
3	United Arab Emirates	9.8	182	Pakistan	0.8
4	Mongolia	9.5	183	Rwanda	0.8
5	Bahrain	8.7	184	Afghanistan	0.8
6	USA	8.4	185	Congo	0.8
7	Canada	8.0	186	Haiti	0.7
8	Kuwait	7.6	187	Burundi	0.6
9	Denmark	7.1	188	Timor	0.6
10	Australia	6.9	189	Eritrea	0.5

Table 7 - Overview of the countries in the world and their Ecological Footprint

N°	**Country**	**Biocapacity Reserve** (gha/person)

1	Finland	**12.9**
2	Sweden	**9.7**
3	Estonia	**9.7**
4	Latvia	**8.0**
5	Norway	**7.4**
6	Russia	**6.9**
7	Lithuania	**5.0**

Table 8 - Overview of the countries in Europe which have Biocapacity Reserve

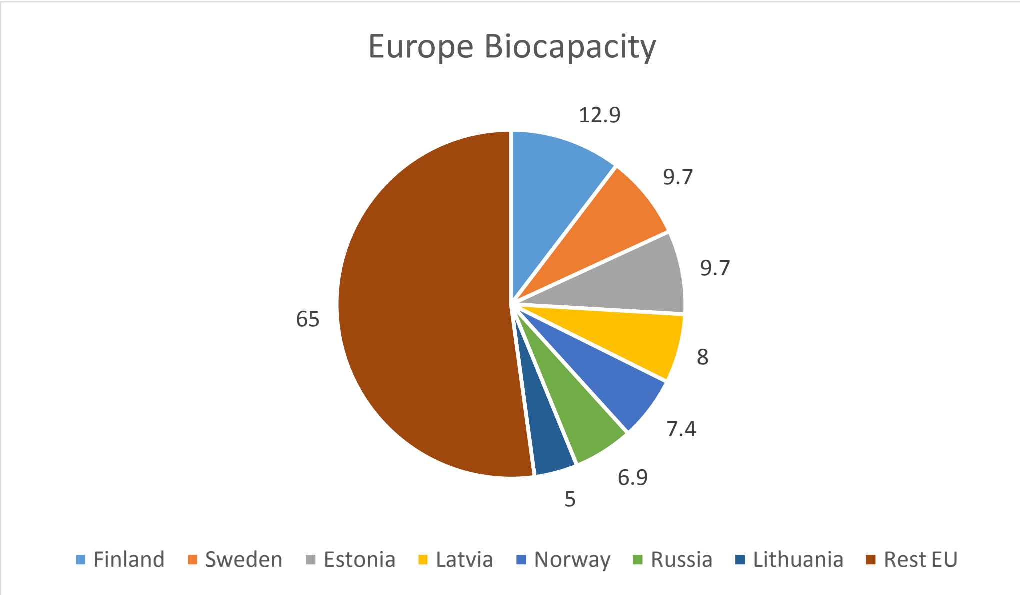

Figure 10 - Overview of the Biocapacity of seven countries with the highest amount, and the rest of the EU

N°	Country	Biocapacity
1	Brazil	**15%**
2	China	**11%**
3	United States	**10%**
4	Russia	**8%**
5	India	**5%**
6	Others	**52%**

Table 9 - Overview of the Biocapacity of five countries with the highest amount, and the rest of the world

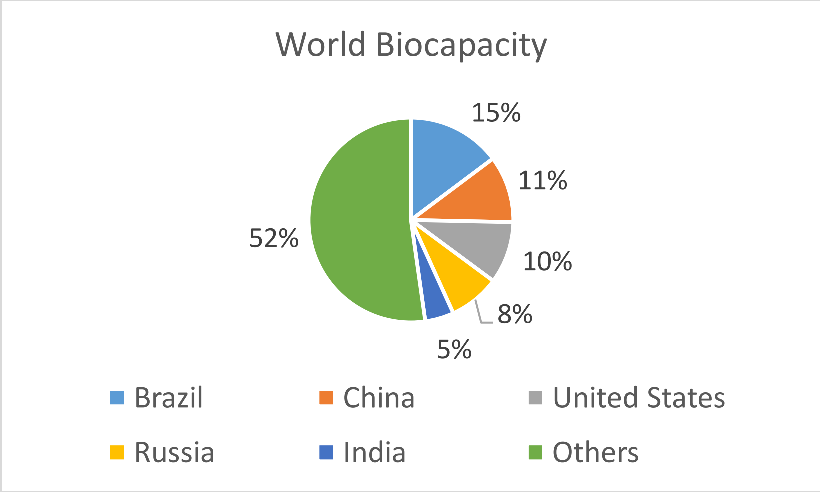

Figure 11 - Overview of the Biocapacity of five countries with the highest amount, and the rest of the world (Global Footprint Network, 2018)

Some population units consume and emit more than others

If our concern is the creation of new consumers and emitters, our gaze should be drawn to those who consume and emit the most, i.e., the wealthy.

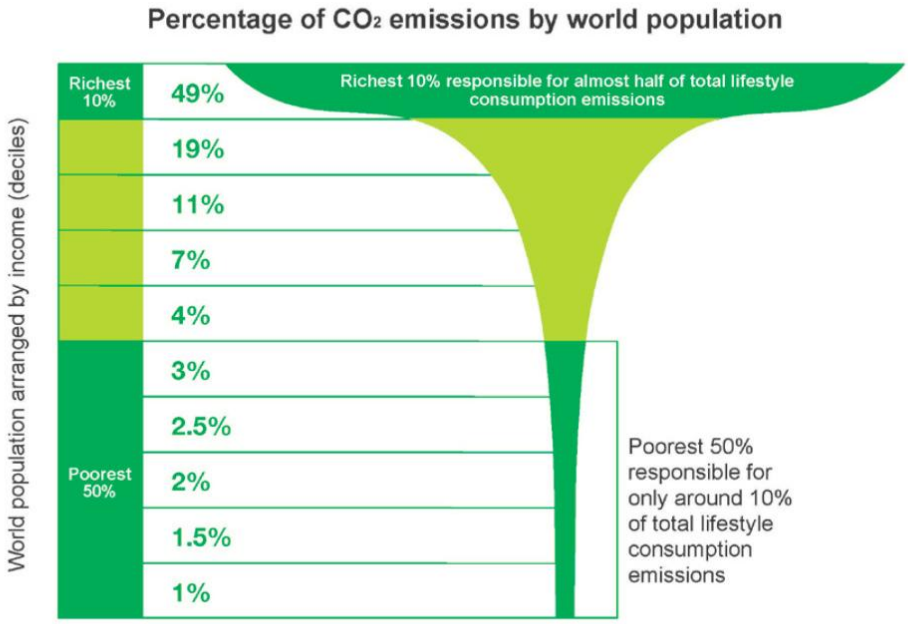

Figure 12 - Global income and associated lifestyle consumption emissions (Roberts, 2019)

The biggest and the smallest worldwide Ecological Footprints in 2014

Country, region	Global hectares per capita		
	Biocapacity	**Ecological Footprint**	**Ecological Deficit (-) or Reserve (+)**
Worldwide average	**1.68**	**2.84**	**- 1.16**
High income countries	**2.91**	**6.12**	**- 3.21**
Middle income countries	**1.58**	**2.43**	**- 0.85**
Low income countries	**1.10**	**1.12**	**- 0.02**

Table 10 - Ecological Footprint and Biocapacity of countries and regions by income (Source: Global Footprint Network)

Country, region	gha per capita		
	BC	EF	Ecological Deficit (-)
Qatar	1.2	15.7	-14.5
Luxembourg	1.4	12.3	-10.9
U. Arab Emirates	0.6	9.8	-9.2
Bahrain	0.5	8.7	-8.2
Kuwait	0.6	7.6	-7.0
Bermuda	0.1	6.8	-6.6
Aruba	0.6	6.4	-5.8
Singapore	0.1	5.9	-5.8
Belgium	0.9	6.7	-5.8
Saudi Arabia	0.4	6.0	-5.6
Réunion	0.2	5.4	-5.2
Cayman Islands	0.3	5.5	-5.2
Korea, Republic of	0.7	5.8	-5.1
Trinidad & Tobago	1.6	6.7	-5.1
Netherlands	0.9	5.9	-5.1
USA	3.6	8.4	-4.8
Oman	1.5	6.3	-4.8
Cook Islands	1.2	6.0	-4.8
Kiribati	1.3	5.8	-4.6
Israel	0.3	4.7	-4.4
Malta	0.6	4.9	-4.3
Japan	0.6	4.7	-4.1
Martinique	0.4	4.5	-4.1
Switzerland	1.1	4.9	-3.8
Guadeloupe	0.5	4.1	-3.7
Libya	0.7	4.3	-3.6
United Kingdom	1.2	4.8	-3.6
Barbados	0.2	3.6	-3.4
Italy	0.9	4.3	-3.4
Montserrat	1.4	4.6	-3.3
Germany	1.8	5.0	-3.3
Antigua & Barbuda	0.9	4.2	-3.3
North Macedonia	1.6	3.1	-1.5

Country, region	gha per capita		
	BC	EF	Ecological Reserve (+)
Fr. Guiana	102.9	2.6	100.3
Suriname	88.2	3.6	84.6
Guyana	68.8	2.9	65.9
Gabon	25.7	2.7	23.0
Bolivia	16.5	3.1	13.4
Congo	10.5	1.2	9.3
Uruguay	10.3	3.0	7.3
Canada	15.2	8.0	7.2
Finland	12.9	6.1	6.8
Paraguay	10.4	3.7	6.7
Australia	13.3	6.9	6.4
C. A. R.	7.4	1.1	6.2
Brazil	8.9	3.1	5.8
Mongolia	15.0	9.5	5.5
New Zealand	9.9	5.1	4.8
Bahamas	9.3	4.8	4.5
Namibia	6.5	2.1	4.4
Sweden	9.7	6.6	3.2
Argentina	6.7	3.7	3.0
Estonia	9.7	7.0	2.8
Latvia	8.0	5.6	2.4
Mauritania	4.4	2.3	2.0
Papua N.G.	3.8	1.8	2.0
Congo	2.7	0.8	1.9
Colombia	3.7	1.9	1.8
Guinea-B.	2.9	1.3	1.6
Madagascar	2.5	1.0	1.5
Peru	3.8	2.3	1.5
Norway	7.4	6.0	1.4
Russia	6.9	5.6	1.3
Liberia	2.4	1.2	1.2
Timor-Leste	1.7	0.6	1.1
Zambia	2.0	1.0	1.0

Table 11 - Ecological Deficit or Ecological Reserve of countries and regions (Source: Global Footprint Network, 2014)

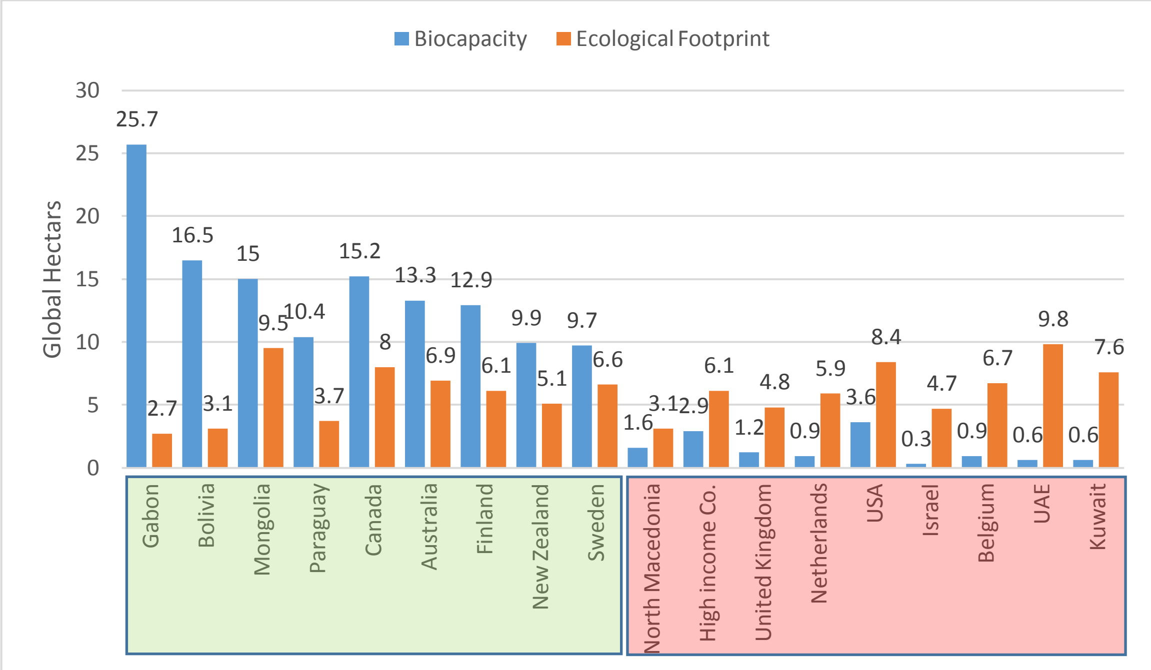

Figure 13 - Ecological Footprint and Biocapacity of countries and regions (Source: Global Footprint Network, 2014)

Balkan Country	Total Biocapacity	Total Ecological Footprint	Biocapacity (Deficit) or Reserve	Number of Earths required	Number of countries required
Romania	2.7	2.6	0.1	1.5	1.0
Bulgaria	3.1	3.1	0.0	1.8	1.0
Montenegro	3.1	3.6	-0.5	2.1	1.2
Croatia	2.8	3.8	-1.0	2.2	1.4
Albania	1.2	2.3	-1.1	1.3	1.9
N. Macedonia	1.6	3.1	-1.5	1.8	2.0
Serbia	1.6	3.1	-1.5	1.8	2.0
Bosnia and Herzegovina	1.7	3.2	-1.5	1.9	1.9
Slovenia	2.3	4.7	-2.4	2.8	2.1
Greece	1.5	4.2	-2.7	2.5	2.8

Table 12 - Ecological Footprint and Biocapacity of Balkan countries

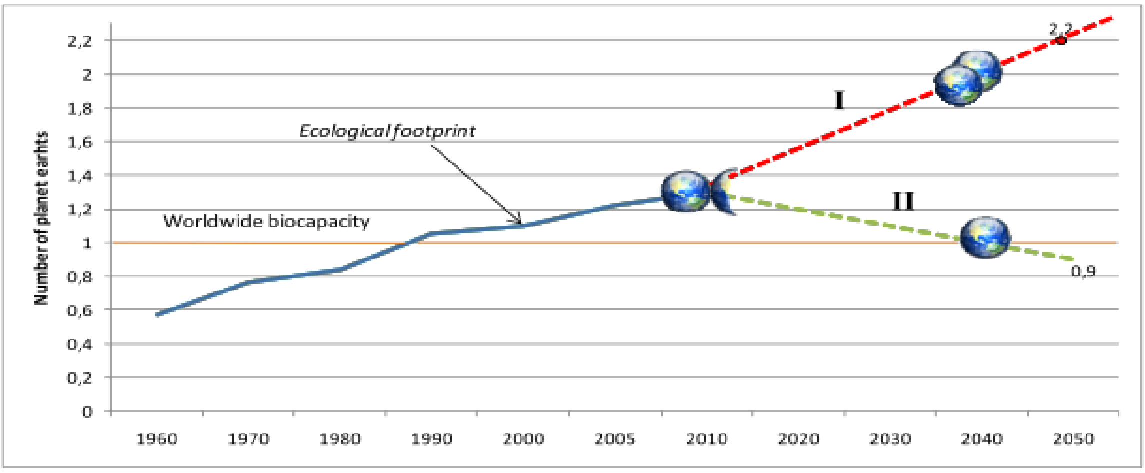

Figure 14 - Possible scenarios of our planet's ecological development (Ruževičius, 2010)

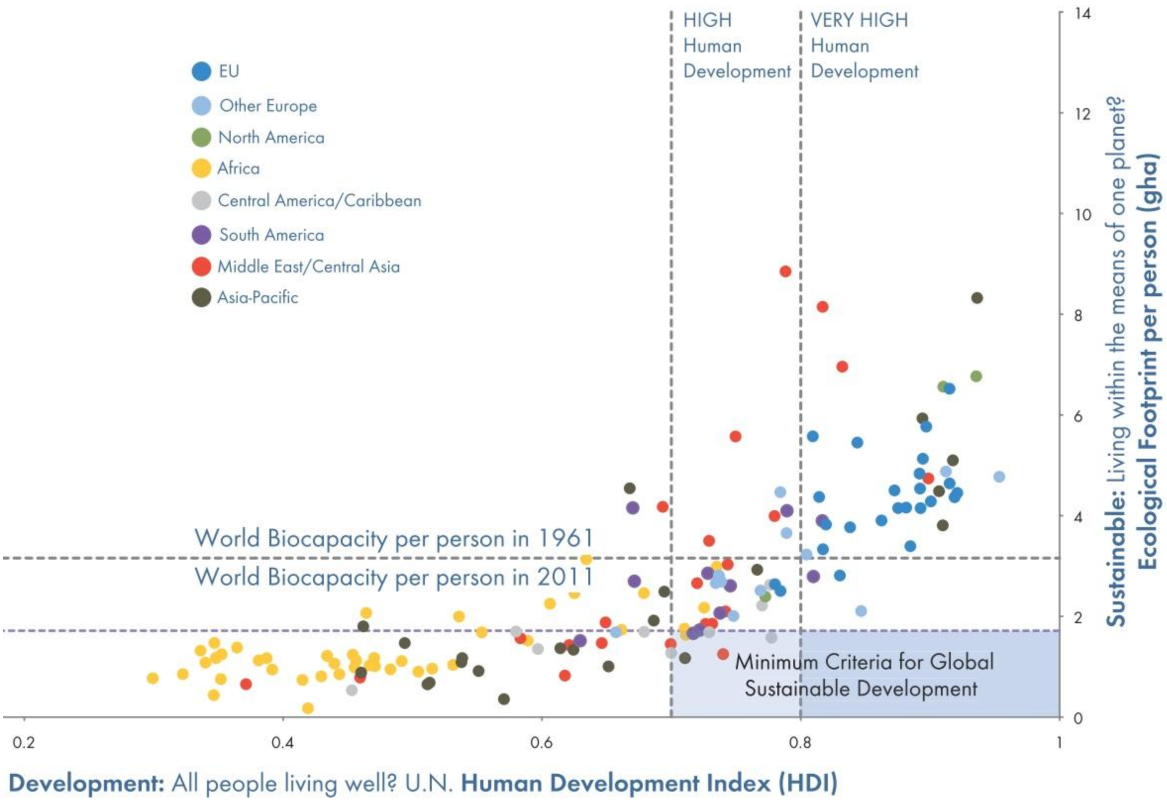

Figure 15 - Human Development Index and Ecological Footprint per person for nations (United Nations, 2013)

Annex for Chapter 5

How products can have positive and negative impacts on consumers

Products can have both positive and negative impacts on consumers by providing them with necessary things for survival, such as nutrition, but, in turn, the process to produce this nutrition may be harming the environment that humans live in through pollution, greenhouse gas emissions, etc.

Consuming a product which has positive impacts on the environment, society, and/or economy

By consuming products that have been raised and produced in an environmentally-friendly manner, positive impacts can be observed on the environment, society, and the economy. For example, buying organic food is good for the environment because no hormones or pesticides are used on the food. It is good for society because it is a healthier alternative to food that is filled with by-products and fillers. The economy will also benefit because with fewer chemicals that are put into food and sprayed onto food, there will be less greenhouse gas emissions and pollution. Therefore, less government money will be needed to clean up the environment to make it livable. In the following sections we will present two products (pizza and refrigerators), and their impact.

Social, environmental, and economic impacts of pizza

- *Social* - pizza is a product that is frequently consumed in social settings. It is well-liked by people all around the country because it is so flexible; people can individualize it according to their own tastes and preferences. As a result, it is a uniting factor for all generations.
- *Environmental* - the different ingredients that go into pizza can have many different environmental repercussions because they involve both meat and produce. Because of this, many different resources are needed for production and transportation.
- *Economic* - many different restaurants and fast-food joints sell pizza; once again, because it can be modified according to whoever is ordering it, pizza is a very popular food to eat at any time of the day. The economy will most likely benefit from pizza sales. However, it may also decline because of the measures that need to be taken in order to clean up the environment as a result of the emissions produced from the making of pizza.
- *Alternatives* - some of the ingredients that are found in a typical pizza are not beneficial to the environment or to human health. Alternatives to cheese and crust, such as cauliflower, would help to improve both. (Roach, 2015)

Analysis of a refrigerator

A refrigerator is an extremely common household appliance that we are sure virtually everyone has in their kitchen. The inner workings of a typical refrigerator are far more complex than the average person would think. There are many different components that make up a properly functioning refrigerator.

As is the same for all electronic products, such as cellphones, computers or televisions, it is mostly non-renewable resources that go into the making of a refrigerator. Metal and plastic are the main components, along with certain chemicals that have to do specifically with the cooling and insulating aspects.

The stage of consumption is where refrigerators differ from other products, such as shoes or cellphones, because people will only buy a refrigerator out of necessity and not just because a new model or advanced technology is being released. One thing about our modern times is that things are not made to last. Furthermore, it is these very products that must continue to be replaced, which are made from non-renewable resources, and the system to dispose of these products is extremely weak. An old, used refrigerator is either exported to a developing country to be stripped of parts and then taken to a landfill, or it may be incinerated, which releases many toxins and emissions into the atmosphere.

Up to the year 1995 manufacturers often used chlorofluorocarbons, known as CFCs, for the manufacturing of refrigerators. When such a harmful gas is used, it flows into the atmosphere, either immediately or years later, in the upper atmosphere, and it pollutes the environment. CFC was one of the major working fluids in refrigerators and the chlorine would break down molecules of ozone, which would result in serious ozone depletion years. But chlorofluorocarbons have been banned by many national and international governments of today.

Mercury is another hazardous chemical compound which could be found in some of the major components of the refrigerators and freezers manufactured in the XX century. Mercury consumed by people at different levels can cause serious issues with neurological development, as well as other problems related to the nervous system. Mercury is used in switches and relays in a manufactured refrigerator.

Positive vs. negative impact

The Ecological Footprint that a person leaves by using refrigerators impacts the communities that an individual interacts with. The kind of cost that they cause is an economic impact.

The waste from the item would increase very quickly, causing a complicated problem to deal with.

Over time, the Ecological Footprint has increased. This is most likely due to urbanization, and the increase in industrialization with the Industrial Age. In part, this increase is also due to increases in the economic quality of life that many rich countries enjoy. Indoor plumbing, central heating, telephones, automobiles, and electric lights have all increased the quality of life and the amount of productive land a person's resource use requires.

Does lessening our impacts necessarily mean reducing our quality of life? Why, or why not? No, because there are alternatives that work just as well as the original product.

How might businesses be encouraged to produce these items in ways that have more positive impacts on the environment and on people? They can be offered government incentives, as well as look for cheaper alternatives to reduce the cost of production.

Often, negative impacts associated with an item are not paid directly by the people who purchase and use the items. Who might end up paying for those impacts? Why do we think these impacts are not included in an item's purchase price? Future generations might end up paying for those impacts. We believe that these impacts are not included in an item's purchase price because it does not directly impact the producer – later on it will be a problem, but in order to keep costs down, they are not included. (mkunkel900, 2015)

Annex for Chapter 6

Questionnaire

What Is Your Ecological Footprint?

I FOOD

How often do you eat animal-based products? (beef, pork, chicken, fish, eggs, dairy products)

1. How often do you eat beef or lamb?

- ☐ Never
- ☐ Infrequently (once every few weeks)
- ☐ Occasionally (once or twice a week)
- ☐ Often (nearly every day)
- ☐ Very often (nearly every meal)

2. How often do you eat pork?

- ☐ Never
- ☐ Infrequently (once every few weeks)
- ☐ Occasionally (once or twice a week)
- ☐ Often (nearly every day)
- ☐ Very often (nearly every meal)

3. How often do you eat poultry?

- ☐ Never
- ☐ Infrequently (once every few weeks)
- ☐ Occasionally (once or twice a week)
- ☐ Often (nearly every day)
- ☐ Very often (nearly every meal)

4. How often do you eat fish or shellfish?

- ☐ Never
- ☐ Infrequently (once every few weeks)
- ☐ Occasionally (once or twice a week)
- ☐ Often (nearly every day)
- ☐ Very often (nearly every meal)

5. How often do you eat eggs, cheese and/or dairy products?

- ☐ Never
- ☐ Infrequently (once every few weeks)
- ☐ Occasionally (once or twice a week)
- ☐ Often (nearly every day)
- ☐ Very often (nearly every meal)

How much of the food you eat is unprocessed, unpackaged or locally grown (less than 320 km)?

6. How much of your diet is fresh, unpackaged foods? Rate in percentages from 0% to maximum 100%. (Fill in the blank) _______ % of my diet is fresh, unpackaged foods.

7. How much of your diet is locally grown or produced?
Rate in percentages from 0% to maximum 100%. (Fill in the blank)

_______ % of my diet is locally grown or produced.

II HOUSING

8. Which housing type best describes your home?

- ☐ Freestanding, no running water
- ☐ Freestanding, running water
- ☐ Multi-storey apartment
- ☐ Duplex, row house or building with 2-4 housing units
- ☐ Luxury condominium

9. Size of the home

- ☐ Tiny (up to 15 m^2)
- ☐ Small (from 15 m^2 to 45m^2)
- ☐ Medium (from 45 m^2 to 140m^2)
- ☐ Large (from 140 m^2 to 465m^2)
- ☐ Huge (from 465 m^2 to 1395m^2)

10. What material is your home constructed with?

- ☐ Straw/bamboo
- ☐ Wood
- ☐ Brick/concrete
- ☐ Adobe
- ☐ Steel/other

11. What percentage of your home's electricity comes from renewable sources?
(either directly or through purchased green power) Rate in percentages from 0% to maximum 100%. (Fill in the blank)

_______ % of my home's electricity comes from renewable sources.

12. How many people live in your household?

☐	1	Just me	☐	6	Persons
☐	2	Persons	☐	7	Persons
☐	3	Persons	☐	8	Persons
☐	4	Persons	☐	9	Persons
☐	5	Persons	☐	10+	Persons

13. Do you have electricity in your home?

☐ YES ☐ NO

14. How energy-efficient is your home?

- ☐ Very inefficient (poor insulation, few LED lamps, heating/cooling systems used often)
- ☐ Below average (inefficient lighting, standard appliances)
- ☐ Average (modern appliances, climate controls)
- ☐ Above average (well insulated, efficient lighting and appliances, careful use)
- ☐ Efficiency-centered (passive heating/cooling, advanced temperature control & ventilation, low electricity use)

III PRODUCTS AND SERVICES

15. What comes closest to your monthly new clothing, footwear and/or sporting goods purchases?

- ☐ Minimal to none
- ☐ Not much (underwear and socks)
- ☐ Average (shirts, underwear, socks)
- ☐ Above average (shoes, pants, shirts, underwear, socks)
- ☐ A lot (several new outfits and shoes every month)

16. How often do you purchase new household appliances?

- ☐ Never, rarely (I don't purchase major appliances for my home)
- ☐ Infrequently (I only replace broken appliances as needed)
- ☐ Occasionally (I sometimes replace out-of-date appliances with new models)
- ☐ Often (I replace most of my appliances with the latest models)
- ☐ Very often (I always have the latest and greatest appliances)

17. How often do you purchase new electronics and gadgets?

- ☐ Never, rarely (I upgrade my mobile phone every few years)
- ☐ Infrequently (I generally only replace broken TVs, computers)
- ☐ Occasionally (I replace out-of-date models and occasionally buy a new gadget)
- ☐ Often (I own many of the newest gadgets on the market)
- ☐ Very often (I always have the latest and greatest gadgets)

18. How often do you purchase new books, magazines and newspapers?

- ☐ Never, rarely (I buy a newspaper, magazine or new book a few times a year)
- ☐ Infrequently (I read most of the news online and borrow many of the books and magazines I read)
- ☐ Occasionally (I read some news online and subscribe to a couple of magazines or newspapers)
- ☐ Often (I often get a newspaper and buy books or magazines every week or two)
- ☐ Very often (I get a daily newspaper and buy books or magazines several times a week)

19. What comes closest to your annual new household furnishings purchases?

- ☐ Minimal to none
- ☐ Not much (I haven't decorated in years, maybe just new towels and sheets)
- ☐ Average (new bedding and a lamp or table, just to spruce things up)
- ☐ Above average (a couch or new bedroom set - I like to change it up)
- ☐ A lot (I completely refurnish my living room, it's an annual ritual)

20. How much paper do you recycle?

- ☐ Little to none
- ☐ Some
- ☐ Half
- ☐ Most
- ☐ All

21. How much plastic do you recycle?

- ☐ Little to none
- ☐ Some
- ☐ Half

- ☐ Most
- ☐ All

IV TRANSPORTATION

22. How far do you travel by car or motorcycle a week? (as a driver or passenger)

Rate in kilometers from 0 km to maximum 800 km. (Fill in the blank)

Each week I travel _______ km by car.

Each week I travel _______ km by motorcycle.

23. What is the average fuel economy of the vehicles you use most often?

Family or personal vehicle

Rate in liters per kilometer from 24 l/km (inefficient) to minimum 2 l/km (efficient or electric car). (Fill in the blank)

The average fuel economy of my vehicle is _______ l/km

Family or personal motorcycle

Rate in liters per kilometer from 9 l/km (inefficient) to minimum 2 l/km (efficient or electric car). (Fill in the blank)

The average fuel economy of my motorcycle is _______ l/km

24. When you travel by car, how often do you carpool?

- ☐ 0% - 20% = Never
- ☐ 21% - 40% = Infrequently
- ☐ 41% - 60% = Occasionally
- ☐ 61% - 80% = Often
- ☐ 81% - 100% = Always

How far do you travel on public transportation a week? (bus, train, etc.)

25. How far do you travel by train a week?
Rate in kilometers from 0 km to maximum 800 km. (Fill in the blank)

I travel _______ km by train a week.

26. How far do you travel by bus a week?
Rate in kilometers from 0 km to maximum 800 km. (Fill in the blank)

I travel _______ km by bus a year.

27. How many hours do you fly a year?

Rate in hours from 0 h to maximum 200 h. (Fill in the blank)

I fly _______ hours a year.

Name and Surname ___________________________

Gender: ☐Female ☐Male

Age __________________

Participants' Responses

Question 1. How often do you eat beef or lamb?

Never	24%
Infrequently	37%
Occasionally	24%
Often	13%
Very often	1%

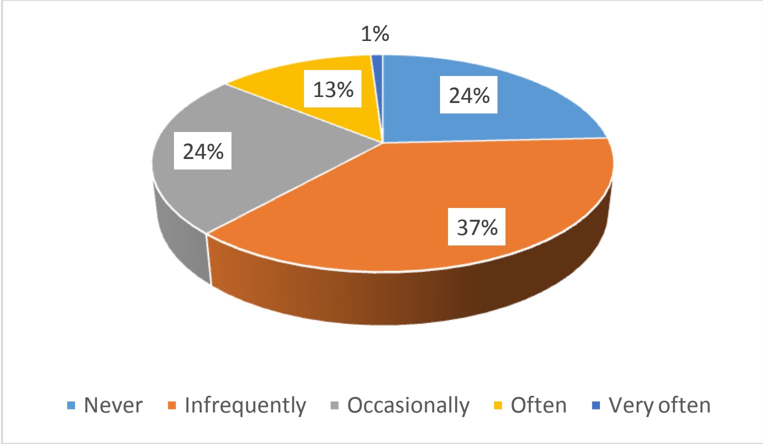

Chart 1: 76% of the respondents consume beef or lamb.

Question 2. How often do you eat pork?

Never	31%
Infrequently	40%
Occasionally	23%
Often	3%
Very often	3%

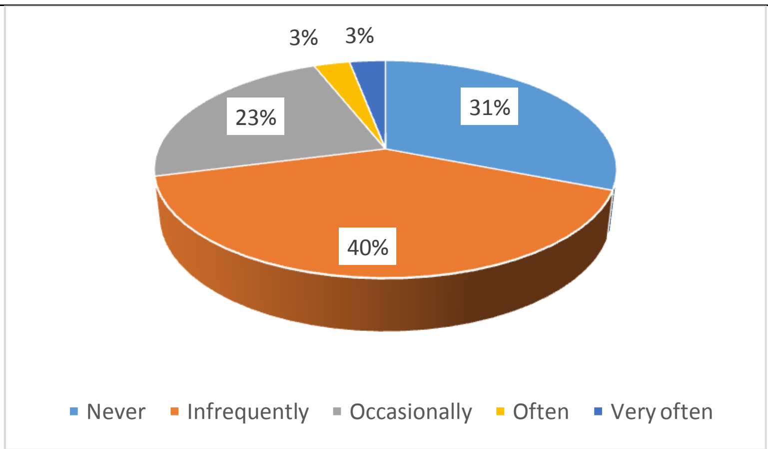

Chart 2: 69% of the respondents consume pork.

Question 3. How often do you eat poultry?

Never	17%
Infrequently	30%
Occasionally	36%
Often	14%
Very often	3%

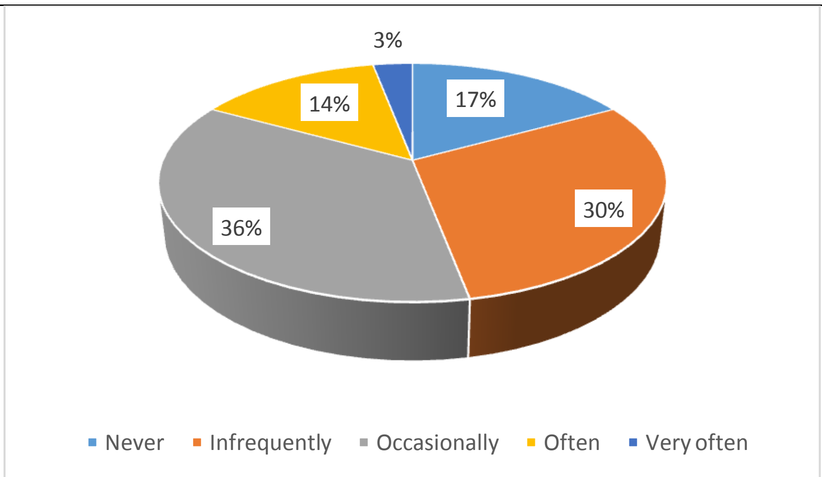

Chart 3: 83% of the respondents consume poultry.

Question 4. How often do you eat fish or shellfish?

Never	14%
Infrequently	63%
Occasionally	19%
Often	4%
Very often	0%

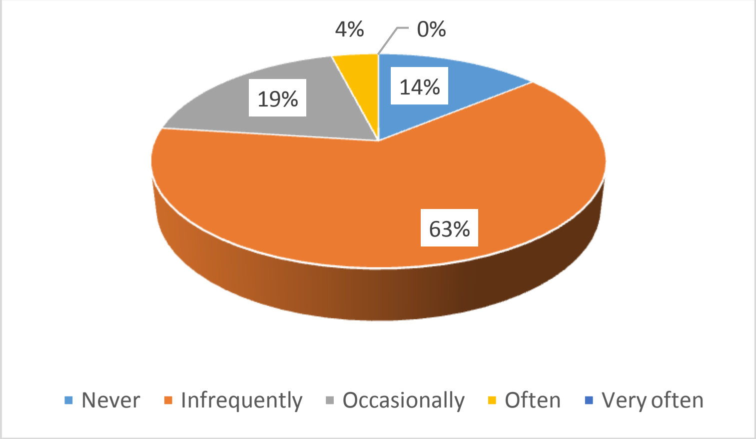

Chart 4: 86% of the respondents consume fish or shellfish.

Question 5. How often do you eat eggs, cheese and/or dairy products?

Never	0%
Infrequently	7%
Occasionally	21%
Often	56%
Very often	16%

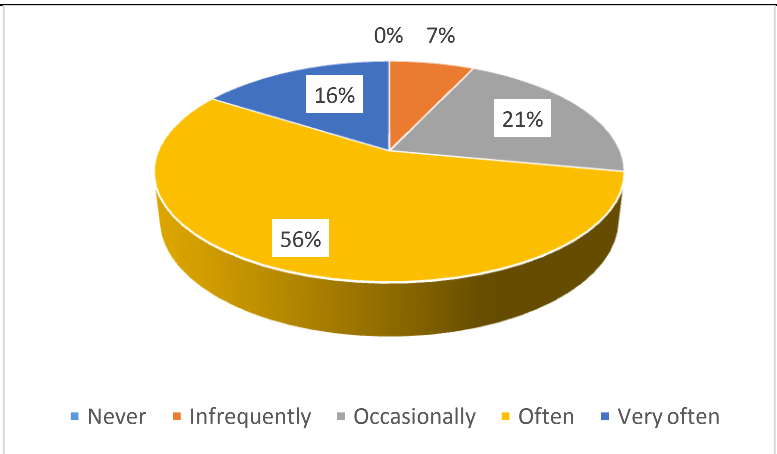

Chart 5: all respondents consume eggs, cheese and/or dairy products.

Question 6. How much of your diet is fresh, unpackaged foods?

0% - 20%	10%
21% - 40%	29%
41% - 60%	33%
61% - 80%	26%
81% - 100%	3%

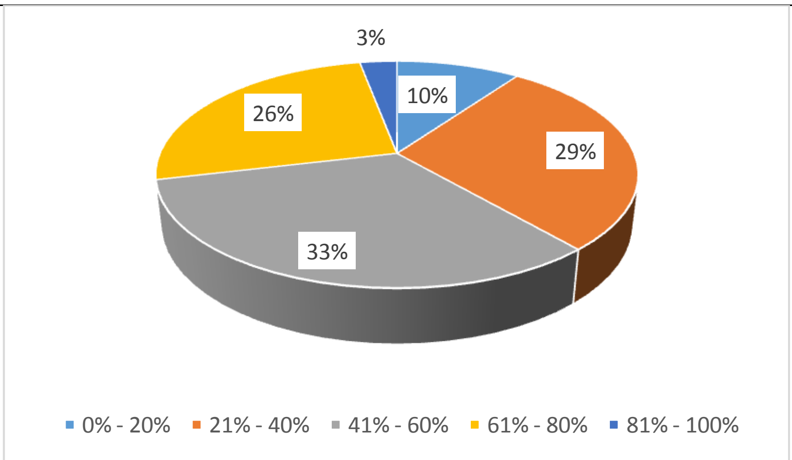

Chart 6: 90% of the respondents consume fresh, unpackaged foods.

Question 7. How much of your diet is locally grown or produced?

0% - 20%	17%
21% - 40%	20%
41% - 60%	34%
61% - 80%	26%
81% - 100%	3%

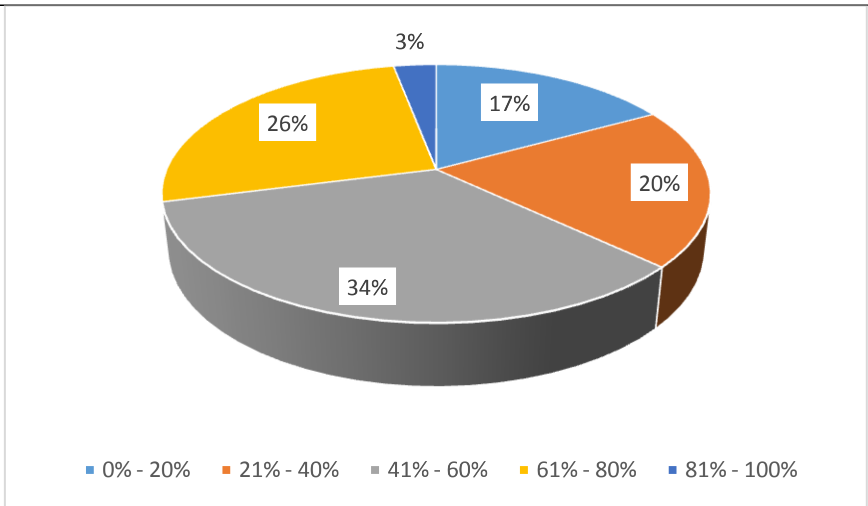

Chart 7: 83% of the respondents' diet is locally grown or produced.

Question 8. Which housing type best describes your home?

Freestanding, no running water	7%
Freestanding, running water	47%
Multi-storey apartment	26%
Duplex, row house or building with 2 - 4 housing units	16%
Luxury condominium	4%

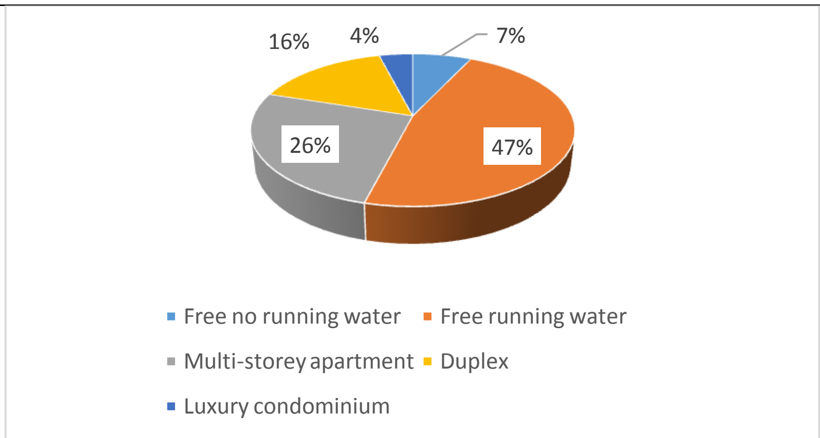

Chart 8: 70% of the respondents live in a house, while the rest live in an apartment.

Question 9. Size of the home

Tiny (0 m^2 - 15 m^2)	0%
Small (15 - 45 m^2)	1%
Medium (45 - 140 m^2)	71%
Large (140 - 465 m^2)	24%
Huge (465 - 1395 m^2)	3%

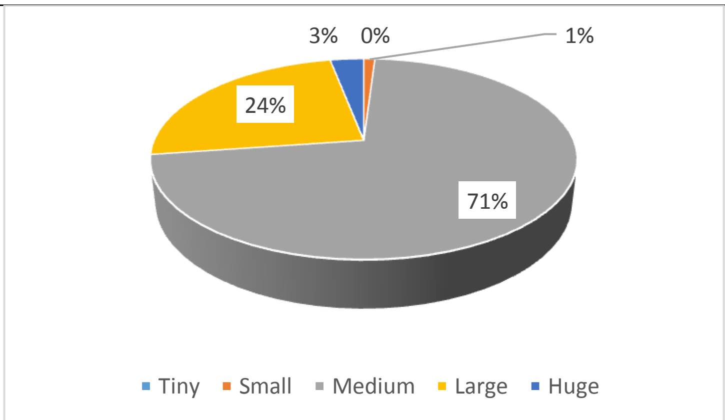

Chart 9: 99% of the respondents live in a housing space that is larger than 45m^2.

Question 10. What material is your home constructed with?

Straw/bamboo	0%
Wood	3%
Brick/concrete	94%
Adobe	0%
Steel/other	3%

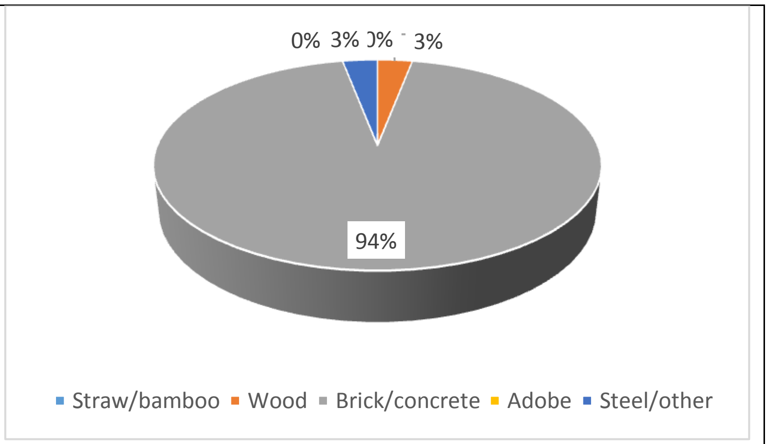

Chart 10: 94% of the respondents' houses are built of brick or concrete.

Question 11. What percentage of your home's electricity comes from renewable sources?

0% - 20%	76%
21% - 40%	11%
41% - 60%	4%
61% - 80%	6%
81% - 100%	3%

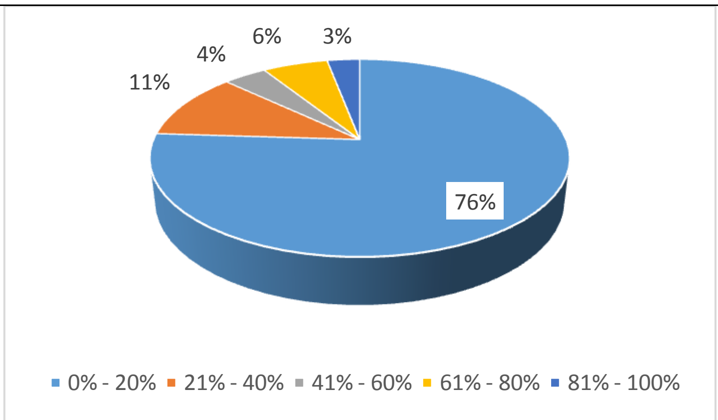

Chart 11: only 24% of the respondents use electricity from renewable sources.

Question 12. How many people live in your household?

2	10%
3	20%
4	39%
5	17%
6	6%
7	3%
9	1%
10+	4%

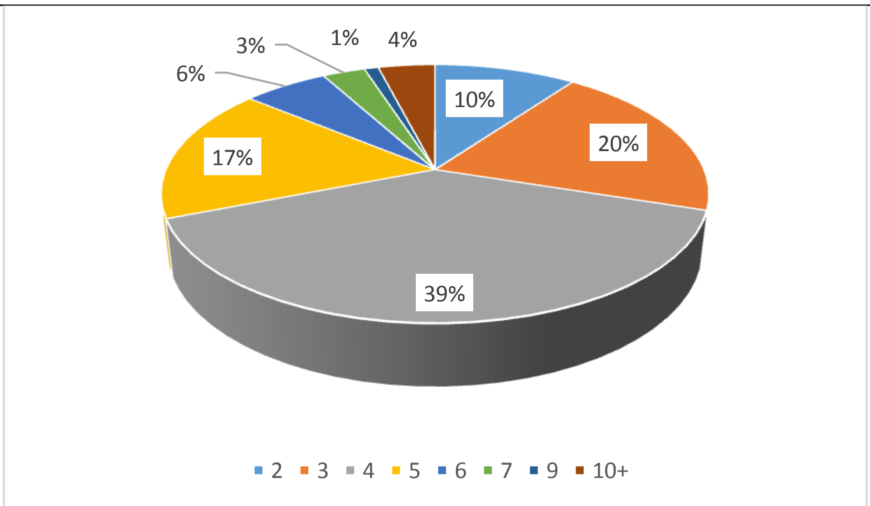

Chart 12: 30% of the respondents share the housing space with two or three people, while 70% live in larger communities.

Question 13. Do you have electricity in your home?

All respondents have electricity, or 100%, so the table and chart are unnecessary.

Question 14. How energy-efficient is your home?

Very inefficient	4%
Below average	11%
Average	56%
Above average	27%
Efficiency-centered	1%

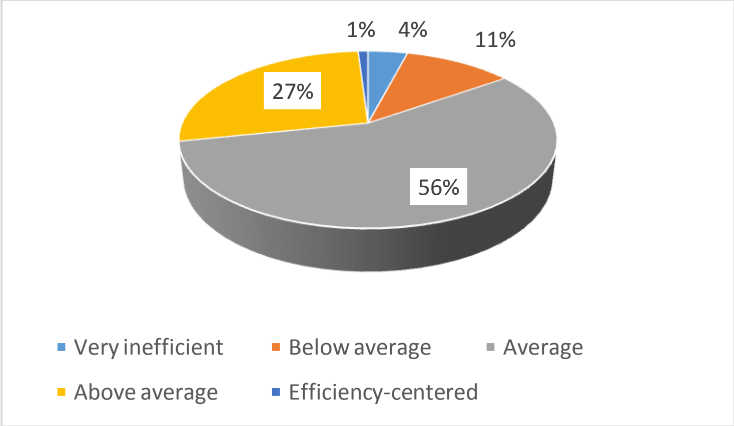

Chart 13: 71% of the respondents have inadequate-to medium-energy-efficient homes.

Question 15. What comes closest to your monthly new clothing, footwear and/or sporting goods purchases?

Minimal to none	14%
Not much	21%
Average	43%
Above average	20%
A lot	1%

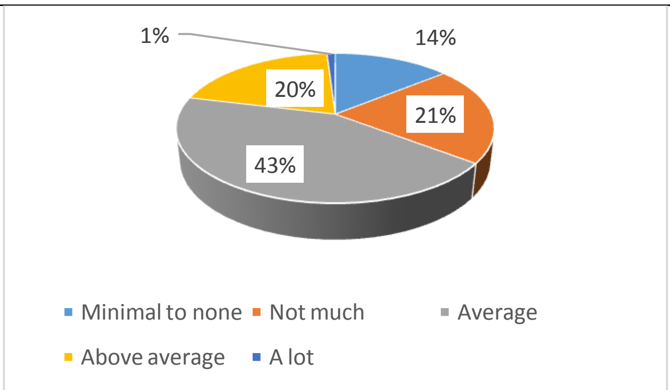

Chart 14: 86% of the respondents buy new clothes, footwear and sports accessories.

Question 16. How often do you purchase new household appliances?

Never	14%
Infrequently	50%
Occasionally	33%
Often	3%
Very often	0%

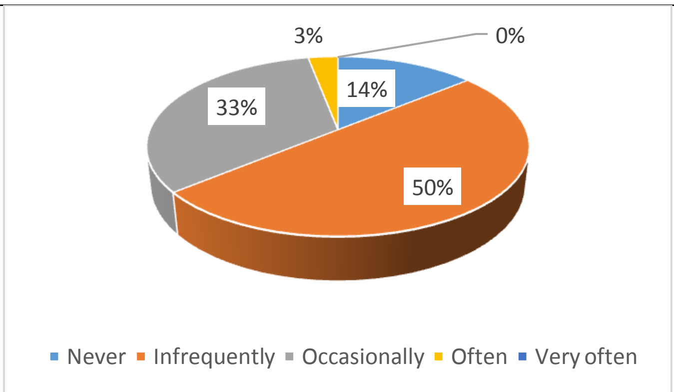

Chart 15: 86% of the respondents buy new household appliances.

Question 17. How often do you purchase new electronics and gadgets?

Never	24%
Infrequently	39%
Occasionally	27%
Often	10%
Very often	0%

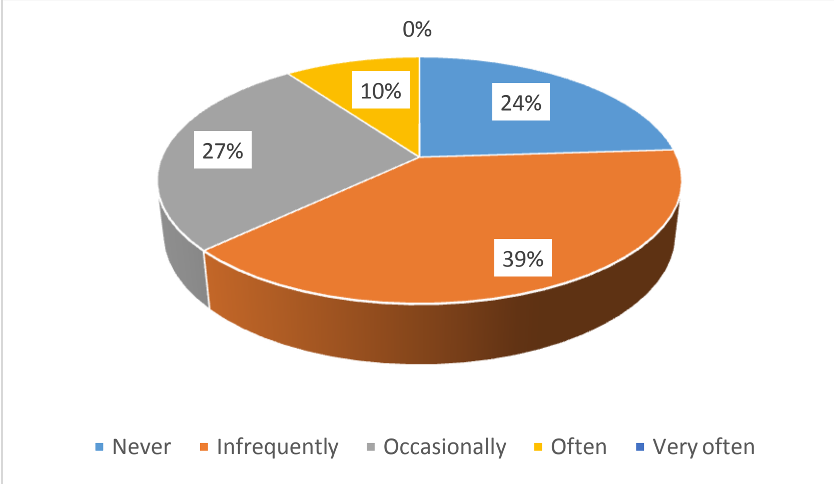

Chart 16: 76% of the respondents buy new electronics and gadgets.

Question 18. How often do you purchase new books, magazines and newspapers?

Never	23%
Infrequently	33%
Occasionally	29%
Often	9%
Very often	7%

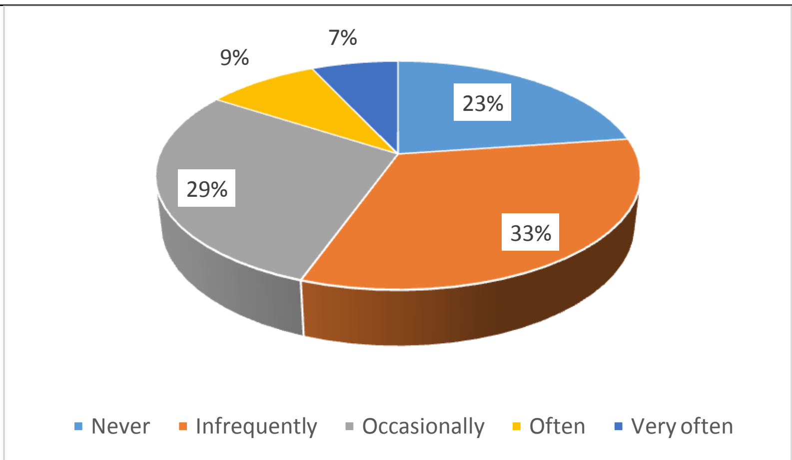

Chart 17: 77% of the respondents buy new books, magazines and newspapers.

Question 19. What comes closest to your annual new household furnishings purchases?

Minimal to none	16%
Not much	33%
Average	46%
Above average	6%
A lot	0%

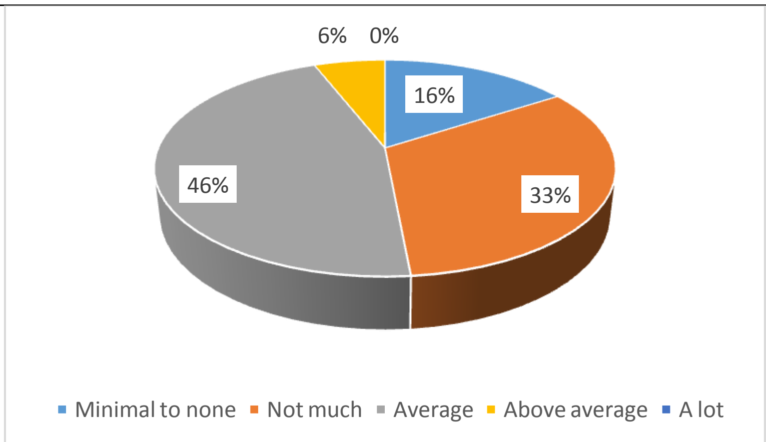

Chart 18: 84% of the respondents buy new household furnishings.

Question 20. How much paper do you recycle?

Little to none	63%
Some	20%
Half	9%
Most	7%
All	1%

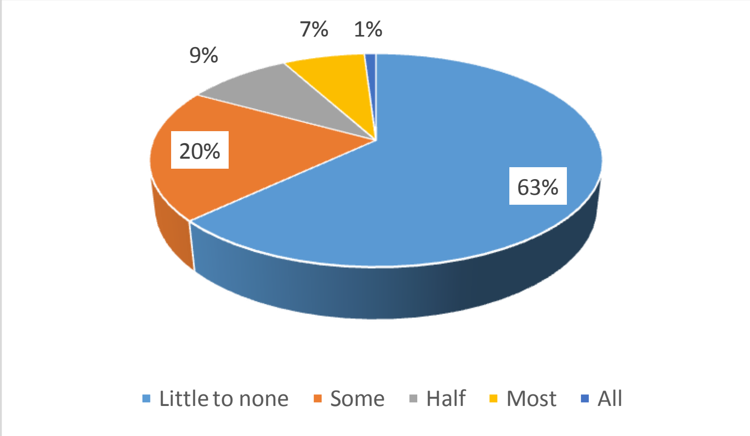

Chart 19: 63% of the respondents do not recycle paper at all.

Question 21. How much plastic do you recycle?

Little to none	59%
Some	21%
Half	10%
Most	9%
All	1%

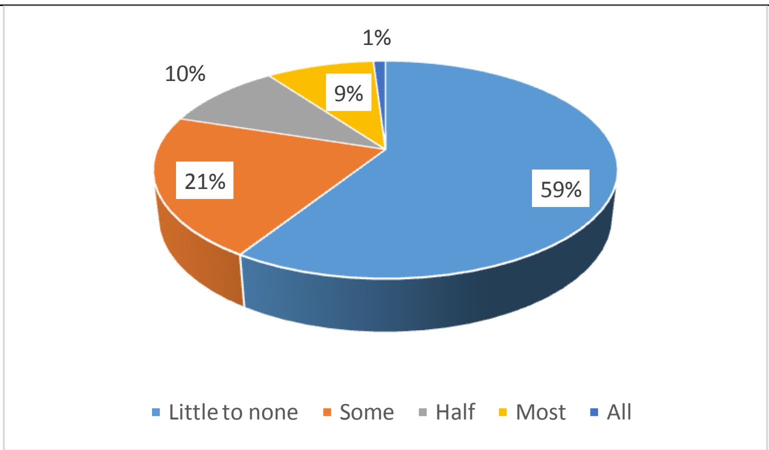

Chart 20: 59% of the respondents do not recycle plastic at all.

Question 22. How far, in km, do you travel by car or motorcycle a week?

0 km - 100 km	73%
101 km - 200 km	7%
201 km - 400 km	16%
401 km - 600 km	3%
601 km - 800 km	1%

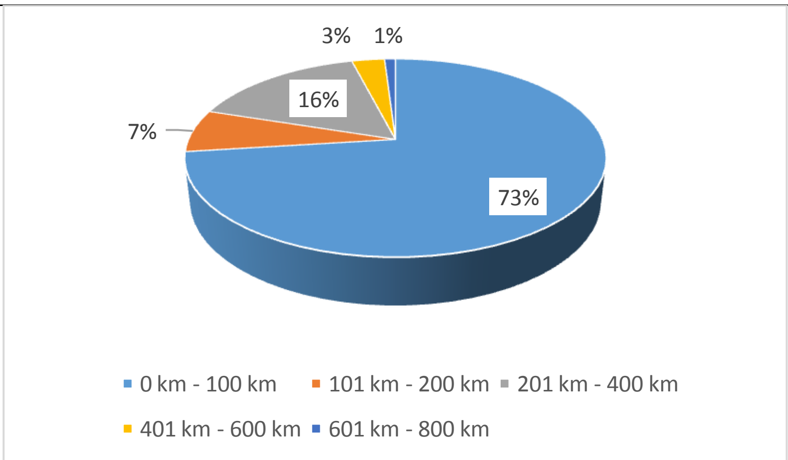

Chart 21: 27% of the respondents travel far distances by car or motorcycle.

Question 23. What is the average fuel economy, in l/km, of the vehicles you use most often?

0 - 4 l/km	27%
4,1 - 8 l/km	50%
8,1 - 12 l/km	17%
12,1 - 16 l/km	3%
16,1 - 20 l/km	3%

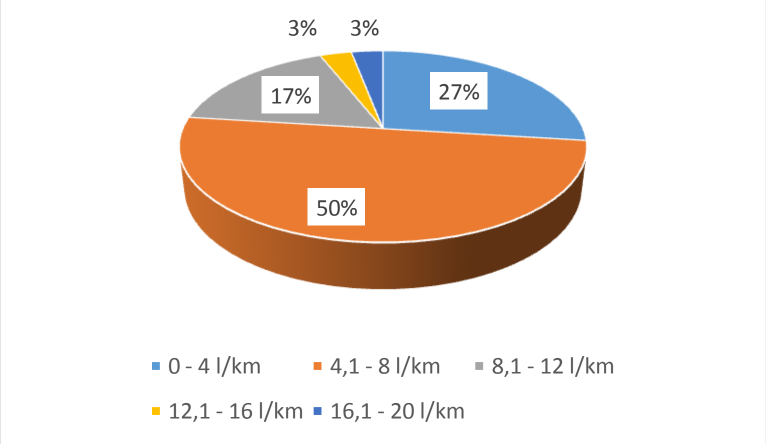

Chart 22: 23% of the respondents use cars with increased consumption.

Question 24. When you travel by car, how often do you carpool?

Never	37%
Infrequently	30%
Occasionally	9%
Often	14%
Always	10%

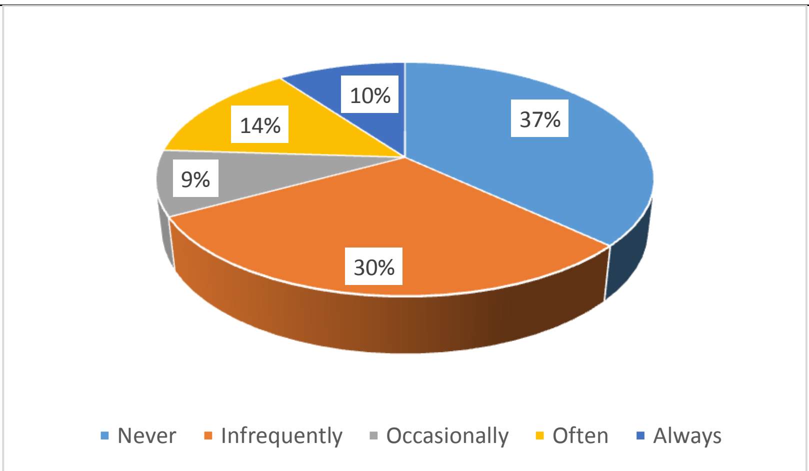

Chart 23: 67% of the respondents very rarely carpool.

Question 25. How far do you travel by train a week?

0 km - 60 km	89%
61 km - 120 km	6%
121 km - 180 km	0%
181 km - 240 km	1%
241 km - 300 km	4%

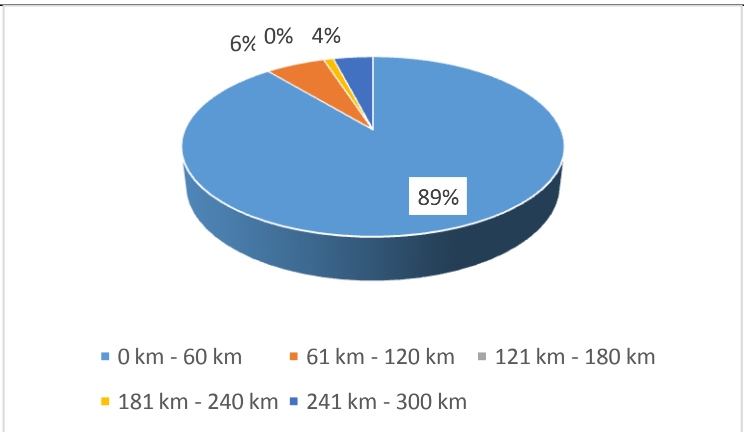

Chart 24: 11% of the respondents travel far distances by train.

Question 26. How far do you travel by bus a week?

0 km - 100 km	64%
101 km - 200 km	17%
201 km - 400 km	14%
401 km - 600 km	3%
601 km - 800 km	1%

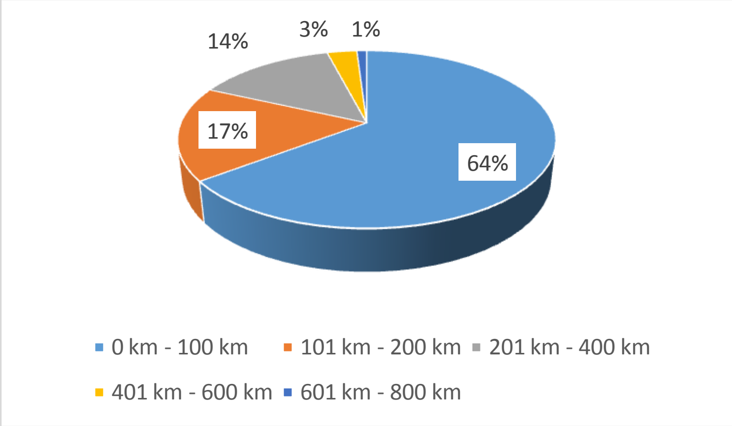

Chart 25: 36% of the respondents travel far distances by bus.

Question 27. How many hours do you fly a year?

0 h - 7 h	89%
7,1 h - 14 h	6%
14,1 h - 21 h	3%
21,1 h -28 h	1%
28,1 h - 35 h	1%

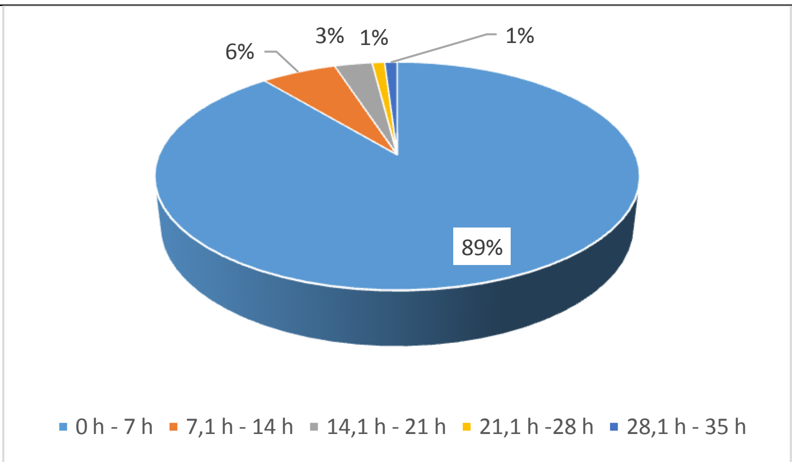

Chart 26: 11% of the respondents travel far distances by plane.

Bibliography

Latin alphabet

1. Bonini, S., Oppenheim, J. (2008). *"Cultivating the Green Consumer"*. Stanford Social Innovation Review, 6, 56-61.
2. Boyle, G. (Ed). (2012). *Renewable energy: power for a sustainable future. 3rd Ed.* Oxford University Press. UK.
3. Credit Suisse. (2014). *Credit Suisse Global Wealth Databook*. Zurich: Credit Suisse Research Institute.
4. D'Sauza, C. (2004). "*Ecolabel programmes: a stakeholder (consumer) perspective*". Corporate Communications: an International Journal, 9 (3), 179-188.
5. Dasgupta, P. (2004). *Human Well-Being and Natural Environment*. New York: Oxford University Press; United Nations International Human Dimensions Programme (UNU-IHDP) and United Nations Environment Programme (UNEP). 2012. Inclusive Wealth Report 2012: Measuring Progress toward Sustainability. Cambridge: Cambridge University Press.
6. *The Future We Want* (2012) – Declaration of the UN Conference on Sustainable Development, Rio.
7. Hancock, T. (2001). "*People, Partnerships and Human Progress: Building Community Capital*". Health Promotion International.
8. Harris, J. Wise, T. Gallagher, K. Goodwin, *R.N.* (2001). *A Survey of Sustainable Development*. Island Press.
9. Hart, S., (January, 1997). *"Beyond Greening: Strategies for a Sustainable World"*, Harvard Business Review.
10. Heinrichs, H., Martens, P., Michelsen, G., Wiek, A. (Eds.). (2016). *Sustainability Science*. Springer.
11. Kearney, J. (2010). "*Food Consumption Trends and Drivers*" Philosophical Transactions of the Royal Society B: Biological Sciences 365(1554): 793-807.
12. Kumar De A. (2004). *Environmental Education*, New Age International (P) Ltd., Publishers, New Delhi.
13. Lawrence, Paul R. (1969). *"How to Deal with Resistance to Change"*, Harvard Business Review, January – February.
14. Marczyk, G., DeMatteo, D. and Festinger, D. (2005). *Essentials of Research Design and Methodology*, Hoboken: John Wiley & Sons, Inc.
15. Matson, P., Clark, W. Anderson, K. (2016). *Pursuing sustainability*. Princeton University Press. New Jersey. USA.
16. Mišković, D. (2013). *Održivi razvoj i zaštita životne sredine*. Alfa-Graf NS. Novi Sad.
17. National Research Council (NRC). (1999). "*Our Common Journey: A Transition to Sustainability*". NRC Board on Sustainable Development. Washington, DC: National Academy Press.
18. Ruževičius, J., & Waginger, E. (2007). "*Eco-labelling in Austria and Lithuania: a comparative study*". Inzinerine Ekonomika-Engineering Economics, 4, 96-102.

Cyrillic alphabet

1. *Агенда 21*, Скратената верзија на Агенда 21 и останатите документи кои произлегоа од Самитот за Земјата во Рио, (1992), Министерство за животна средина и просторно планирање на Република Македонија.
2. Декларација за одржлив развој од Јоханесбург – План за имплементација (Јоханесбург, 2002).
3. Национална проценка за одржлив развој – усвоена од Влада на Република Македонија, јули, 2002.
4. Еверет, Б. Бојл, Г. Пике, С. Рамаж, Џ. (2013). *Енергетски системи и одржливост: моќност за одржлива иднина*. Арс Ламина. Скопје
5. Шапуриќ, З. (2010). "*Животна средина и одржлив развој*". Универзитет Американ Колеџ.

References

Population Matters.org, 2016. *Biocapacity and ecological footprint.* [Online]
Available at: https://populationmatters.org/sites/default/files/SI_21_biocapacity_ecofootprint.pdf
[Accessed 11 April 2019].
ACER, 2016. *The state in the energy sector of the Republic of Macedonia,* Ljubljana: Agency for the Cooperation for Energy Regulators.
Ambasadori održivog razvoja i životne sredine, 2013. *Ekološki otisak - Ecological footprint.* [Online]
Available at: http://ambassadors-env.com/wp-content/uploads/Ecol.-Footprint-2013.pdf
[Accessed 12 March 2019].
Anderson, B. & M'Gonigle, M., 2012. Does ecological economics have a future?. *Ecological Economics,* Volume 84, pp. 37-48.
Anon., 2003-2019. *About Us.* [Online]
Available at: https://www.footprintnetwork.org/about-us/
[Accessed 12 March 2019].
Anon., 2003-2019. *Ecological Footprint.* [Online]
Available at: https://www.footprintnetwork.org/our-work/ecological-footprint/
[Accessed 12 March 2019].
Anon., 2015. *The 2050 Calculator.* [Online]
Available at: https://www.2050.org.uk/what-is-a-2050-calculator
[Accessed 6 March 2019].
Anon., 2019. *How Skopje and other cities in the former Yugoslav Republic of Macedonia help the country meet its targets under the Paris Agreement.* [Online]
Available at: https://medium.com/@UNDP/energy-efficiency-to-reduce-urban-greenhouse-gas-emissions-ee797083c291
[Accessed 6 March 2019].
Anon., 2019. *База на податоци за националните емисии на стакленички гасови.* [Online]
Available at: http://www.unfccc.org.mk/Default.aspx?LCID=244
[Accessed 6 March 2019].
Arto, I., Capellán, I., Lago, R. & Bueno, G., 2014. The energy footprint of human. *XIV Jornadas de economía crítica,* pp. 134-151.
Arto, I. & Dietzenbacher, E., 2014. Drivers of the Growth in Global Greenhouse Gas Emissions. *Environmental Science & Technology,* 48(10), pp. 5388-5394.
Arto, I. et al., 2012. Global Resources Use and Pollution. *Production, Consumption and Trade,* Volume 1, pp. 1995-2008.
Astleithner, F. & Hamedinger, A., 2003. The Analysis of Sustainability Indicators as Socially Constructed Policy Instruments: benefits and challenges of 'interactive research'. *Local Environment,* 8(6), pp. 627-640.
Astleithner, F., Hamedinger, A., Holman, N. & Rydin, Y., 2004. Institutions and indicators – The discourse about indicators in the context of sustainability. *Journal of Housing and the Built Environment,* 19(1), pp. 7-24.
Athanasiadis, I., 2017. *Everyone in the World Should Be Taxed on Their Energy Footprint.* [Online]
Available at: https://bigthink.com/aeon-ideas/everyone-in-the-world-should-be-taxed-on-their-energy-footprint
[Accessed 14 March 2019].
Beder, S., 2011. Environmental economics and ecological economics: the contribution of interdisciplinarity to understanding, influence and effectiveness. *Environmental Conservation,* 38(02), pp. 140-150.

Biermann, F., 2014. The Anthropocene: A Governance Perspective. *The Anthropocene Review,* 1(1), pp. 57-61.
Boezeman, D., Leroy, P., Maas, R. & Kruitwagen, S., 2010. The (limited) political influence of ecological economics: A case study on Dutch environmental policies. *Ecological Economics,* 69(9), pp. 1756-1764.
Borucke, M. et al., 2013. Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecological Indicators,* Volume 24, pp. 518-533.
Braungart, M. & McDonough, W., 2010. *Cradle to Cradle: Remaking the Way We Make Things.* New York: Macmillan.
Brown, M. A., Southworth, F. & Sarzynski, A., 2019. *Shrinking the Carbon Footprint of Metropolitan America.* [Online]
Available at: https://www.brookings.edu/wp-content/uploads/2016/07/carbonfootprint_brief.pdf
[Accessed 1 March 2019].
Brundtland, G. H., 1987. *Report of the World Commission on Environment and Development: Our Common Future,* Oslo: UN World Commission.
Carbon Footprint Ltd, 2019. *RECYCLING.* [Online]
Available at: https://www.carbonfootprint.com/recycling.html
[Accessed 19 April 2019].
Carley, M. J. & Spapens, P., 1998. *Sharing the world: sustainable living and global equity in the 21st century.* London: Earthscan.
Center for Sustainable Economy, 2019. *Reduce your footprint.* [Online]
Available at: http://myfootprint.org/en/take_action/reduce_your_footprint/
[Accessed 19 April 2019].
Clare, D., 2004. Ecolabel programmes: a stakeholder (consumer) perspective. *Corporate Communications: An International Journal,* 9(3), pp. 179-188.
Clini, C. & Ortis, A., 2003. *Integrating Energy and Environmental goals – Investment needs and technology options,* Milan: International Energy Agency.
Collins, A. & Flynn, A., 2015. *The Ecological Footprint: New Developments in Policy and Practice.* Cheltenham: Edward Elgar Publishing Limited.
Commission, T. B., 1987. *Our Common Future.* [Online]
Available at: http://www.un-documents.net/wced-ocf.htm
[Accessed 27 February 2019].
Consulting, E.-S., 2018. *Carbon Footprint Calculations for an Average American.* [Online]
Available at: https://externalassets.cooleffect.org/lib/content/wp-content/uploads/2018/04/05172819/CarbonFootprint_AverageAmerican.pdf
[Accessed 1 March 2019].
Corbett, J., 2008. Carbon Footprint. *Climate Change: In Context*, 5 December, Volume 1, pp. 162-164.
Core Writing Team, Pachauri, R. K. & Meyer, L. eds., 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva, IPCC, p. 151.
Core Writing Team, P. R. a. R. A. (., 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Geneva: IPCC.
COTAP.org - Carbon Offsets To Alleviate Poverty, n.d. *25+ Ways to Reduce Your Carbon Footprint.* [Online]
Available at: https://cotap.org/reduce-carbon-footprint/
[Accessed 19 March 2019].

Cranston, G. R. & Hammond, G. P., 2012. Carbon footprints in a bipolar, climate-constrained world. *Ecological Indicators,* Volume 16, pp. 91-99.
Čuček, L., Klemeš, J. & Kravanja, Z., 2012. A Review of Footprint analysis tools for monitoring impacts on sustainability. *Journal of Cleaner Production,* Volume 34, pp. 9-20.
Čuček, L., Varbanov, P. S., Klemeš, J. J. & Kravanja, Z., 2012. Potential of Total Site Process Integration for Balancing and Decreasing the Key Environmental Footprints. *Chemical Engineering Transactions,* Volume 29, pp. 61-66.
Cutter, S. L. et al., 2008. A place-based model for understanding community resilience to natural disasters. *Global Environmental Change,* pp. 598-606.
Dasgupta, P., 2001. *Human well-being and the natural environment.* Oxford: Oxford University Press.
Davis, S. J. & Caldeira, K., 2010. Consumption-based accounting of CO2 emissions. *Proceedings of the National Academy of Sciences,* 107(12), pp. 5687-5692.
De Benedetto, L. & Klemeš, J., 2009. The Environmental Performance Strategy Map: an integrated LCA approach to support the strategic decision-making process. *Journal of Cleaner Production,* 17(10), pp. 900-906.
Dunlop, C. A., 2014. The Possible Experts: How Epistemic Communities Negotiate Barriers to Knowledge Use in Ecosystems Services Policy. *Environment and Planning C: Government and Policy,* 32(2), pp. 208-228.
EASD Team, 2013. *Ecological footprint,* Beograd: s.n.
Easterlyn, J., 2017. *How much of U.S. carbon dioxide emissions are associated with electricity generation?.* [Online]
Available at: https://www.eia.gov/tools/faqs/faq.php?id=77&t=11
[Accessed 1 March 2019].
Ecogoldprint, 2017. *How to Reduce your Footprint easily.* [Online]
Available at: https://ecogoldprint.com/cany-girl/
[Accessed 18 April 2019].
Energy Community, 2019. *Energy Community.* [Online]
Available at: https://www.energy-community.org/
[Accessed 6 March 2019].
European Parliament, 2013. *General Union Environment Action Programme to 2020.* [Online]
Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386
[Accessed 12 March 2019].
Ewing, B. et al., 2008. *Calculation Methodology for the National Footprint Accounts.* 1 ed. Oakland: Global Footprint Network.
Fang, K., Heijungs, R. & de Snoo, G., 2013. The footprint family: comparison and interaction of the ecological, energy, carbon and water footprints. *Revue de Métallurgie,* 110(1), pp. 77-86.
Fang, K., Heijungs, R. & de Snoo, G. R., 2014. Theoretical exploration for the combination of the ecological, energy, carbon, and water footprints: Overview of a footprint family. *Ecological Indicators,* Volume 36, pp. 508-518.
Feng, K. et al., 2011. Comparison of bottom-up and top-down approaches to calculating the water footprints of nations. *Economic Systems Research,* 23(4), pp. 371-385.
Ferng, J., 2002. Toward a scenario analysis framework for energy footprints. *Ecological Economics,* 40(1), pp. 53-69.
Galli, A. et al., 2012. Integrating Ecological, Carbon and Water footprint into a “Footprint Family” of indicators: Definition and role in tracking human pressure on the planet. *Ecological Indicators,* Volume 16, pp. 100-112.
Garbato, K., 2006. *WWF: Choose good wood and save our forests.* [Online]
Available at: http://www.easyvegan.info/2006/07/27/wwf-choose-good-wood-and-save-our-

forests/
[Accessed 19 April 2019].
Geller, H. & Attali, S., 2005. *The Experience with Energy Efficiency policies and programs In IEA Countries: Learning from the Critics,* Paris: International Energy Agency.
GENISIS Project, 2017. *What are Carbon Offsets?.* [Online]
Available at: https://www.genisisproject.org/site/content/what-are-carbon-offsets
[Accessed 19 April 2019].
Giljum, S. et al., 2011. A comprehensive set of resource use indicators from the micro to the macro level. *Resources, Conservation and Recycling,* 55(3), pp. 300-308.
Giljum, S., Hinterberger, F. & Lutter, S., 2008. *Measuring Natural Resource Use: Context, Indicators and EU Policy Processes.* Vienna, Sustainable Europe Research Institute (SERI).
Global Footprint Network, 2003-2019. *Ecological Footprint.* [Online]
Available at: https://www.footprintnetwork.org/our-work/ecological-footprint/
[Accessed 11 April 2019].
Global Footprint Network, 2006. *ECOLOGICAL FOOTPRINT DATA SOURCES.* [Online]
Available at: https://www.footprintnetwork.org/content/documents/EF2006References1.pdf
[Accessed 11 April 2019].
Global Footprint Network, 2010. *Calculation Methodology for the National Footprint Accounts, 2010 Edition.* [Online]
Available at:
https://www.footprintnetwork.org/content/images/uploads/National_Footprint_Accounts_Method_Paper_2010.pdf
[Accessed 12 March 2019].
Global Footprint Network, 2018. *Analyze by Land Types.* [Online]
Available at: http://data.footprintnetwork.org/#/analyzeTrends?type=BCtot&cn=5001
[Accessed 12 March 2019].
Global Footprint Network, 2018. *Country Trends.* [Online]
Available at: http://data.footprintnetwork.org/#/countryTrends?cn=5001&type=BCpc,EFCpc
[Accessed 12 March 2019].
Global Footprint Network, 2018. *Country Trends.* [Online]
Available at: http://data.footprintnetwork.org/#/countryTrends?cn=5001&type=earth
[Accessed 12 March 2019].
Global Footprint Network, 2018. *Free Public Data Set.* [Online]
Available at: https://www.footprintnetwork.org/licenses/public-data-package-free-2018/
[Accessed 12 March 2019].
Global Footprint Network, 2019. *Climate Change.* [Online]
Available at: https://www.footprintnetwork.org/our-work/climate-change/
[Accessed 08 April 2019].
Global Footprint Network, 2019. *Glossary - Consumption Land Use Matrix.* [Online]
Available at: https://www.footprintnetwork.org/resources/glossary/
[Accessed 11 April 2019].
Global Stewards, 2019. *Top 20 Ways to Reduce Your Carbon Footprint.* [Online]
Available at: http://www.globalstewards.org/reduce-carbon-footprint.htm
[Accessed 18 April 109].
Hadley, G., 2006. *A GRAND DESIGN FOR ONE PLANET LIVING.* [Online]
Available at: https://www.wwf.org.uk/updates/grand-design-one-planet-living-0
[Accessed 11 April 2019].

Haines-Young, R. & Potschin, M., 2014. The Ecosystem Approach as a Framework for Understanding Knowledge Utilisation. *Environment and Planning C: Government and Policy,* 32(2), pp. 301-319.
Hancock, T., 2001. People, partnerships and human progress: building community capital. *Health Promotion International,* 16(3), p. 275–280.
Hannigan, J. A., 2006. *Environmental Sociology: A Social Constructionist Perspective.* 2 ed. London: Routledge.
Hassan, R. M., Scholes, R. & Ash, N., 2005. *Ecosystems and human well-being: Current State and Trends,* Washington (DC): Island Press.
Heijungs, R., 2010. Ecodesign — Carbon Footprint — Life Cycle Assessment — Life Cycle Sustainability Analysis. A Flexible Framework for a Continuum of Tools. *Scientific Journal of Riga Technical University. Environmental and Climate Technologies,* 4(1), pp. 42-46.
Hertwich, E. G. & Peters, G. P., 2009. Carbon Footprint of Nations: A Global, Trade-Linked Analysis. *Environmental Science & Technology,* 43(16), pp. 6414-6420.
Herva, M., Franco, A., Carrasco, E. & Roca, E., 2011. Review of corporate environmental indicators. *Journal of Cleaner Production,* 19(15), pp. 1687-1699.
Hezri, A. A. & Dovers, S. R., 2006. Sustainability indicators, policy and governance: Issues for ecological economics. *Ecological Economics,* 60(1), pp. 86-99.
Hille, J., 1997. *The Concept of Environmental Space - Implications for Policies, Environmental Reporting and Assessments,* Copenhagen: EEA.
Hoekstra, A. Y. & Wiedmann, T. O., 2014. Humanity's unsustainable environmental footprint. *Science,* 344(6188), pp. 1114-1117.
Høgevold, N. M., 2003. A corporate effort towards a sustainable business model: A case study from the Norwegian furniture industry. *International Journal of Operations & Production Management,* 23(4), pp. 392-400.
Huijbregts, M. A. J. et al., 2010. Cumulative Energy Demand As Predictor for the Environmental Burden of Commodity Production. *Environmental Science & Technology,* 44(6), pp. 2189-2196.
Illge, L. & Schwarze, R., 2009. A matter of opinion—How ecological and neoclassical environmental economists and think about sustainability and economics. *Ecological Economics,* 68(3), pp. 594-604.
Institute for Statistics, U., 2016. *Adult and Youth Literacy Fact Sheet,* s.l.: UNESCO Institute for Statistics.
Institute for Sustainable Energy, n.d. *Personal Ecological Footprint.* [Online]
Available at:
http://mrproulx.weebly.com/uploads/1/2/8/1/12816005/ecological_footprint_worksheet.pdf
[Accessed 12 March 2019].
Institute, B. S., 2011. *PAS 2050:2011.* [Online]
Available at: https://shop.bsigroup.com/en/forms/PASs/PAS-2050/?_ga=2.51261803.391074946.1551191203-653810842.1551191203
[Accessed 26 February 2019].
Institute, C. S. R., 2018. *Credit Suisse Global Wealth Databook,* Zurich: Credit Suisse.
International Organization for Standardization, 2003. *Kids' ISO 14000 Programme.* [Online]
Available at: https://www.iso.org/news/2003/10/Ref877.html
[Accessed 12 March 2019].
IPBES, 2019. *Main Page.* [Online]
Available at: https://www.ipbes.net/
Jamieson, M., 2014. *Better together: corporate sustainability and energy management programs.* [Online]
Available at: https://blog.schneider-electric.com/energy-management-energy-

efficiency/2014/01/28/better-together-corporate-sustainability-energy-management-programs/
[Accessed 6 March 2019].
Jasch, C., 2000. *Environmental Management Accounting, Procedures and PrinciplesUnited.* [Online]
Available at: http://www.env.go.jp/policy/kaikei/sympo/04.pdf
[Accessed 14 March 2019].
Jones, N. F., Pejchar, L. & Kiesecker, J. M., 2015. The Energy Footprint: How Oil, Natural Gas, and Wind Energy Affect Land for Biodiversity and the Flow of Ecosystem Services. *BioScience,* 65(3), pp. 290-301.
Kingdon, J. W., 1984. *Agendas, alternatives and public policies.* Boston u.a.: Little, Brown.
Kitzes, J. et al., 2009. A research agenda for improving national Ecological Footprint accounts. *Ecological Economics,* 68(7), pp. 1991-2007.
Kitzes, J. & Wackernagel, M., 2009. Answers to common questions in Ecological Footprint accounting. *Ecological Indicators,* 9(4), pp. 812-817.
LeNôtre Alumni, 2018. *Live Green: 5 Tips to save water.* [Online]
Available at: https://www.lenotrehub.com/blog/live-green-5-tips-to-save-water-538
[Accessed 18 April 2019].
Lenzen, M. & Murray, S., 2001. A modified ecological footprint method and its application to Australia. *Ecological Economics,* 37(2), pp. 229-255.
Lowery, M., 2006. *Global Perspective on Energy Efficiency in Developing Countries.* NW Washington, The World Bank.
Lukić, I., 2011. *Analiza Ekološkog Otiska.* [Online]
Available at: http://www.cqm.rs/2011/2/pdf/01.pdf
[Accessed 11 April 2019].
Machingura, F. & Lally, S., 2017. *The Sustainable Development Goals and their trade-offs.* [Online]
Available at: https://www.odi.org/sites/odi.org.uk/files/long-form-downloads/the_sdgs_and_their_trade-offs.pdf
[Accessed 10 April 2019].
Marczyk, G., DeMatteo, D. & Festinger, D., 2005. *Essentials of Research Design and Methodology.* Hoboken: John Wiley & Sons, Inc..
Mason, M. & Zeitoun, M., 2013. Questioning environmental security. *The Geographical Journal,* 179(4), pp. 294-297.
Matson, P. A., Clark, W. C. & Andersson, K., 2016. *Pursuing sustainability.* Princeton: Princeton University Press.
McDonald, S. et al., 2012. Individual strategies for sustainable consumption. *Journal of Marketing Management,* 28(3-4), pp. 445-468.
Messe Frankfurt, 2019. *Sustainability and intelligent energy management in buildings.* [Online]
Available at: https://light-building.messefrankfurt.com/frankfurt/en/programme-events/topthemes/smartification/sustainability.html
[Accessed 6 March 2019].
Messe Frankfurt, 2019. *Sustainability and intelligent energy management in buildings.* [Online]
Available at: https://light-building.messefrankfurt.com/frankfurt/en/programme-events/topthemes/smartification/sustainability.html
[Accessed 13 March 2019].
Ministry of Environment and Physical Planning, 2009. *National Strategy for Sustainable Development for the Republic of Macedonia Part I/II.* [Online]
Available at: http://www.moepp.gov.mk/wp-content/uploads/2014/12/Nacionalna-Strategija-za-Odrzliv-Razvoj-vo-RM-NSSD-Del-1.pdf
[Accessed 10 April 2019].

mkunkel900, 2015. *Analysis of a Refrigerator.* [Online]
Available at: https://ecofootprintassignmentrefrigerator.wordpress.com/2015/02/03/analysis-of-refrigerator/
[Accessed 18 March 2019].
Monfreda, C., Wackernagel, M. & Deumling, D., 2004. Establishing national natural capital accounts based on detailed Ecological Footprint and biological capacity assessments. *Land Use Policy,* 21(3), pp. 231-246.
Murray, J. & Dey, C., 2006. *Carbon neutral - sense and sensibility,* Sydney: Centre for Integrated Sustainability Analysis.
Niccolucci, V., Bastianoni, S., Tiezzi, E. B. & Wackernagel, M., 2009. How deep is the footprint? A 3D representation. *Ecological Modelling,* 220(20), pp. 2819-2823.
Niccolucci, V., Rugani, B., Botto, S. & Gaggi, C., 2010. An integratedfootprintbased approach for environmental labelling of products: the case of drinking bottled water. *International Journal of Design & Nature and Ecodynamics,* 5(1), pp. 68-75.
NSSD Project Team, 2008. *National Strategy for Sustainable Development for the Republic of Macedonia.* [Online]
Available at: http://www.moepp.gov.mk/wp-content/uploads/2014/12/NSSD-2-EN.pdf
[Accessed 21 March 2019].
NSSD Project Team, 2008. *Стратегии.* [Online]
Available at: http://www.moepp.gov.mk/wp-content/uploads/2014/12/NSSD-1-EN.pdf
[Accessed 10 May 2019].
OECD/IEA, 2004. *Renewable Energy, Market & Policy Trends – IEA Countries,* Paris: International Energy Agency.
OECD/IEA, 2006. *Energy Technology Perspectives,* Paris: International Energy Agency.
One Tree Planted, 2017. *HOW TO DO SOMETHING POSITIVE FOR OUR AWESOME PLANET.* [Online]
Available at: https://onetreeplanted.org/blogs/news/do-something-positive-awesome-planet
[Accessed 19 April 2019].
Opschoor, H. & Reijnders, L., 1991. Towards sustainable development indicators. In: O. Kuik & H. Verbruggen, eds. *In Search of Indicators of Sustainable Development.* Dordrecht: Springer, pp. 7-27.
Palmer, J. A., 1998. *Environmental Education in the 21st Century: Theory, Practice, Progress and Promise.* London: Routledge.
Parris, T. M. & Kates, R. W., 2003. CHARACTERIZING AND MEASURING SUSTAINABLE DEVELOPMENT. *Annual Review of Environment and Resources,* 14 August, 28(1), pp. 559-586.
Peleah, M. & Ivanov, A., 2017. *Sustainable Human Development Index—a pragmatic proposal for monitoring sustainability within the affordable limits.* Seoul, s.n.
Pelling, M. & High, C., 2005. Understanding Adaptation: What Can Social Capital Offer Assessments of Adaptive Capacity?. *Global Environmental Change,* 15(4), pp. 308-319.
Penn State Personal Web Space, n.d. *WHAT'S IN A FOOTPRINT: ECOLOGICAL FOOTPRINT ANALYSIS.* [Online]
Available at: http://personal.psu.edu/cfu1/CUhlpersonalwebsite/stepstones/chrisuhl-stepstones-10-eco-footprint.pdf
[Accessed 12 March 2019].
Peters, G. P., Minx, J. C., Weber, C. L. & Edenhofer, O., 2011. Growth in emission transfers via international trade from 1990 to 2008. *Proceedings of the National Academy of Sciences,* 108(21), pp. 8903-8908.
Radunsky, K., 2011. *United for one cause - Managing greenhouse gas emissions in the supply chain.* [Online]

Available at: https://www.iso.org/news/2011/05/Ref1616.html
[Accessed 11 April 2019].
Rees, W. E., 1992. Ecological footprints and appropriated carrying capacity: what urban economics leaves out. *Environment and Urbanization,* 4(2), pp. 121-130.
Rees, W. E., 2002. Footprint: our impact on Earth is getting heavier. *Nature,* 420(6913), pp. 267-268.
Rees, W. E., 2002. Globalization and Sustainability: Conflict or Convergence?. *Bulletin of Science, Technology & Society,* 22(4), pp. 249-268.
Ridoutt, B. G. & Pfister, S., 2013. Towards an Integrated Family of Footprint Indicators. *Journal of Industrial Ecology,* 17(3), pp. 337-339.
Roach, J., 2015. *Ecological Footprint and Human Impacts of.* [Online]
Available at: https://prezi.com/arq6-vclooxg/ecological-footprint-and-human-impacts-of/
[Accessed 18 Marxh 2019].
Roberts, D., 2019. *I'm an environmental journalist, but I never write about overpopulation. Here's why..* [Online]
Available at: https://www.vox.com/energy-and-environment/2017/9/26/16356524/the-population-question
[Accessed 12 March 2019].
Ruteh, S. S., 2011. Energy management and sustainable development. *Energy and Sustainability III,* pp. 159-171.
Ruteh, S. S., 2011. Energy Management And Sustainable Development. *WIT Transactions on Ecology and the Environment,* Volume 143, pp. 159 - 171.
Ruževičius, 2010. *Possible scenarios of our planet's ecological development.* [Art] (ResearchGate).
Ruževičius, J., 2010. ECOLOGICAL FOOTPRINT AS AN INDICATOR OF SUSTAINABLE DEVELOPMENT. *ECONOMICS AND MANAGEMENT,* Volume 15, pp. 711-718.
Ruževičius, J., 2010. Ecological footprint: Evaluation methodology and international benchmarking. *Verslo ir teisės aktualijos,* 6(1), pp. 11-30.
Ruževičius, J. & Waginger, E., 2007. Eco-labelling in Austria and Lithuania: a Comparative Study. *Engineering Economics,* 54(4), pp. 96-102.
SEE Change Canbera, 2019. *Carbon Emissions as Part of the Ecological Footprint.* [Online]
Available at: http://www.see-change.org.au/wp-content/uploads/2015/02/Carbon-Emissions-as-Part-of-the-Ecological-Footprint_0.pdf
[Accessed 19 March 2019].
SEEU, 2019. *Energy Management and Sustainable Development.* [Online]
Available at: https://www.masterstudies.com/Energy-Management-and-Sustainable-Development/Macedonia/SEEU/
[Accessed 6 March 2019].
Siche, J., Agostinho, F., Ortega, E. & Romeiro, A., 2008. Sustainability of nations by indices: Comparative study between environmental sustainability index, ecological footprint and the emergy performance indices. *Ecological Economics,* 66(4), pp. 628-637.
Šimleša, D., 2010. *Ekološki otisak - Kako je razvoj zgazio održivost.* 1 ed. Zagreb: TIM Press.
Steen-Olsen, K. et al., 2012. Carbon, Land, and Water Footprint Accounts for the European Union: Consumption, Production, and Displacements through International Trade. *Environmental Science & Technology,* 46(20), pp. 10883-10891.
Stoeglehner, G. & Narodoslawsky, M., 2008. Implementing ecological footprinting in decision-making processes. *Land Use Policy,* 25(3), pp. 421-431.
Stöglehner, G., 2003. Ecological footprint — a tool for assessing sustainable energy supplies. *Journal of Cleaner Production,* 11(3), pp. 267-277.

The Guardian, n.d. *How to reduce your carbon footprint.* [Online]
Available at: https://www.theguardian.com/environment/2017/jan/19/how-to-reduce-carbon-footprint
[Accessed 19 March 2019].
Trudell, J., 2017. *10 easy ways to reduce your carbon footprint.* [Online]
Available at: https://rare.us/rare-life/10-easy-ways-to-reduce-your-carbon-footprint/
[Accessed 18 March 2019].
Trust, C., 2019. *What is a carbon footprint?.* [Online]
Available at:
https://web.archive.org/web/20090511102744/http:/www.carbontrust.co.uk/solutions/CarbonFootprinting/what_is_a_carbon_footprint.htm
[Accessed 27 February 2019].
Turner, T., n.d. *How Big is My Ecological Footprint?.* [Online]
Available at:
http://www.geaugaswcd.com/yahoo_site_admin/assets/docs/Ecological_Footprint.145121606.pdf
[Accessed 12 March 2019].
Uhl, C., 2003. *Developing ecological consciousness: path to a sustainable world.* New York: Rowman & Littlefield publ..
UN, 1992. *United Nations Framework Convention on Climate Change.* [Online]
Available at: https://unfccc.int/resource/docs/convkp/conveng.pdf
[Accessed 18 March 2019].
UNDP, 2013. *The Rise of the South: Human Progress in a Diverse World,* New York: UNDP.
UNDP, 2018. *Human Development Indices and Indicators 2018 Statistical Update,* New York: UNDP.
United Nations, 2013. *Human Development Index.* [Online]
Available at: https://www.footprintnetwork.org/content/images/efhdisdgi.jpg
[Accessed 12 March 2019].
United Nations, 2019. *Major Agreements & Conventions.* [Online]
Available at: https://sustainabledevelopment.un.org/index.php?menu=122
[Accessed 10 May 2019].
UNU-IHDP & UNEP, 2014. *Measuring progress toward sustainability. Summary for Decision-Makers.,* Delhi: UNU-IHDP.
Van Den Bergh, J. C. & Verbruggen, H., 1999. Spatial sustainability, trade and indicators: an evaluation of the ‘ecological footprint’. *Ecological Economics,* 29(1), pp. 61-72.
Van Den Bergh, J. & Grazi, F., 2010. On the Policy Relevance of Ecological Footprints. *Environmental Science & Technology,* 44(13), pp. 4843-4844.
Van Vuuren, D. & Smeets, E., 2001. Ecological footprints: reply to A.R.B Ferguson. *Ecological Economics,* 37(1), pp. 2-3.
Wackernagel, M. & Rees, W. E., 1996. *Our ecological footprint: Reducing human impact on the Earth.* Gabriola Island: Philadelphia: New Society.
Wackernagel, M. & Rees, W. E., 1997. Perceptual and structural barriers to investing in natural capital: Economics from an ecological footprint perspective. *Ecological Economics,* 20(1), pp. 3-24.
Weiss, C. H. & Connell, J. P., 1995. Nothing as Practical as Good Theory: Exploring Theory-based Evaluation for Comprehensive Community Initiatives for Children and Families. In: J. P. Connell, A. C. Kubich, L. Schorr & C. H. Weiss, eds. *New Approaches to Evaluating Community Initiatives: Concepts, Methods, and Contexts.* Washington(DC): Aspen Institute, pp. 65-92.
Whalen, C., 2017. *15 things to do to improve your climate impact.* [Online]
Available at: https://www.carboncommentary.com/blog/2017/1/20/15-things-to-do-to-improve-

your-climate-impact
[Accessed 18 April 2019].
Wiedmann, T., 2009. A review of recent multi-region input–output models used for consumption-based emission and resource accounting. *Ecological Economics,* 69(2), pp. 211-222.
Wiedmann, T. & Minx, J. C., 2008. A Definition of 'Carbon Footprint. In: C. C. Pertsova, ed. *Ecological Economics Research Trends.* Hauppauge(NY): Nova Science Publishers, pp. 1-11.
World Bank Group, 2007. *Catalyzing Private Investment for a low Carbon Economy,* NW Washington: World Bank Group.
World Bank Staff, 2006. *An Investment Framework for Clean Energy and Development: A Progress Report,* NW Washington: World Bank.
WWF - World Wide Fund for Nature, n.d. *Energy Efficiency.* [Online]
Available at: http://wwf.panda.org/get_involved/live_green/energy_efficiency/
[Accessed 19 March 2019].
wwf.panda.org, 2018. *LIVING PLANET REPORT 2018: Aiming higher.* [Online]
Available at: https://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/
[Accessed 12 March 2019].
WWF, 2005. *Forests flushed down the toilet.* [Online]
Available at: http://gftn.panda.org/?50660/Forests-flushed-down-the-toilet
[Accessed 19 April 2019].
WWF, 2019. *Energy Efficiency.* [Online]
Available at: http://wwf.panda.org/get_involved/live_green/energy_efficiency/
[Accessed 18 April 2019].
WWF, 2019. *Travel Light.* [Online]
Available at: https://wwf.panda.org/get_involved/live_green/travel/
[Accessed 19 April 2019].